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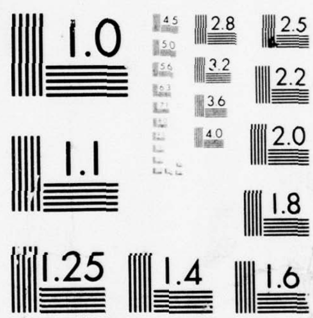

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DEFINITION, DESCRIPTION, AND INTERFACES OF THE FAA'S DEVELOPMENTAL PROGRAMS

VOLUME I: OVERVIEW

SEPTEMBER 1978

Document is available to the public through the National Technical Information Service, Springfield, Virginia 22151

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Office of Systems Engineering Management
Washington, D.C. 20591

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16. Abstract

This report provides an overview of the evolution of the Air Traffic Control System facilities in the pre-1990 time period as major system improvements currently being developed by the FAA are implemented. The description was prepared to assist FAA managers with the technical planning for the future air traffic control system. The description covers eight major domestic ATC facility classifications: En Route, TRACON, Tower, ATC System Command Center, Flight Service Stations, Surveillance, Navigation, and Communications. The report provides a summary description of each improvement currently being planned, describes the information flow between ATC facilities to support the improvement, and provides tentative implementation dates for each improvement. More detailed information on each facility class is given in Volume II of this series. An overall ATC system configuration is given in this Volume to show the relationship of these facilities to each other once the improvements are in place. Some of the major assumptions involved in developing this overall configuration are cited. A single thread description of an air carrier flight through high density airspace is also given to indicate the effect the planned improvements would have on Instrument Flight Rule operations.

Terminal radar approach control

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PREFACE

The system described in this document was prepared to make explicit the system interfaces implied by the current FAA program of planned ATC system improvements and to identify those interfaces that merit FAA planning attention. The descriptions in this document were based on information available to the authors as of September 1978. Specific features of the system described herein may be modified as the development cycle provides more information about the technical feasibility and operational desirability of proposed improvements. Also, some improvements may be deferred or dropped from the program and others will be expedited or added as the perceived operational needs of the ATC system, internal FAA priorities, and availability of funds change over time. Thus, while this document may be viewed as an aid to the technical planning for system implementation, it does not necessarily reflect the ATC system that will actually be in place by a given time period, nor does it imply that the FAA is committed to the implementation of all or any of the features described in this report.

ACKNOWLEDGEMENTS

This document, "Definition, Description, and Interfaces of the FAA's Developmental Programs," is based on the assimilation of information from many sources. Many people contributed information as to the description and status of various programs aimed at providing incremental improvements to the ATC System. Various levels of coordination were conducted with FAA personnel concerned with individual program elements that are expected to be a part of the ATC System at some future point in time. Drafts of this document were submitted to the Systems Research and Development Service (SRDS), Airway Facilities Service (AAF), Air Traffic Service (AAT), Flight Standards Service (AFS), National Aviation Facilities Experimental Center (NAFEC), Office of Aviation System Plans (ASP), and Office of Aviation Policy (AVP). The material in this document reflects this coordination cycle. The authors, of course, assume full responsibility for any remaining errors.

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1. INTRODUCTION

1.1 Background

Approximately ten years ago, in the summer of 1968, the Department of Transportation (DOT) in conjunction with the Federal Aviation Administration (FAA) formed an Air Traffic Control Advisory Committee (ATCAC) for the purpose of recommending an Air Traffic Control (ATC) system for the 1980's and beyond. The ATCAC's technical staff included representation from all segments of the aviation industry and related government agencies including the FAA, the DoD, and the National Aeronautics and Space Administration (NASA). Its recommendations as to how the ATC system should evolve during the 1970's and 1980's provided the basis for many of the FAA's development efforts in subsequent years and, in a sense, provided a summary description of how the ATCAC thought the ATC system should look in the late 1970's and the 1980's.

In 1972, the FAA published a document on the "Concepts, Design and Description for the Upgraded Third Generation ATC System." That document was in essence a description of how the FAA's Engineering and Development (E&D) community thought the future ATC system would evolve if the E&D programs underway or planned at that time were implemented. The document emphasized possible future operational capabilities rather than technical and operational interfaces since many of the planned improvements were still in the conceptual stage. For the most part, the 1972 future ATC system description was an expansion of the ATCAC description to reflect the FAA work that had been accomplished in the intervening years.

Some time later, the DOT conducted an extensive review of the FAA's E&D program aimed at providing products for the evolutionary improvement of the ATC system. The resultant DOT report recommended that the FAA's E&D program, then in progress, be pursued but indicated that a description of how the various improvements would work together in the operational system was desirable.

Still later, the FAA's Office of Systems Engineering Management (OSEM) tasked The MITRE Corporation to develop a description of the ATC system as it might look in the future after the products of the E&D program were implemented.

1.2 Purpose

The purpose of the system description effort as defined by the Office of Systems Engineering Management was to:

- Describe the Conterminous U.S. Air Traffic Control (ATC) system after current major E&D features are developed and integrated into the operational system.

- Identify and describe the interfaces that would have to be provided between the system elements.

- Identify and describe design and time phasing aspects of the program that required action on the part of the FAA.

This document, Volume I, provides a summary and an overview of the results of that work. A companion document, Volume II, contains more detailed information on the expected improvements

to FAA operated ATC facilities. In addition, at the conclusion of each facility description in Volume II, an interface planning summary cites two types of system concerns: "Interface/Evolution Open Items" and "Interface Adjustments." The topics included in the Open Items discuss system design/configuration options that the FAA will be addressing during the evolution of the ATC system. They also involve major assumptions that were made as to how the ATC system will incorporate the results of the FAA E&D program. The second area, "Interface Adjustments," describes some small changes that would be considered by the FAA program managers in improving the interface between certain subsystems.

1.3 Scope

The scope of this project was limited to those systems within Conterminous U.S. that are operated by the FAA and that are directly related to the provision of ATC services. In addition, the system improvements described were limited to those items in the current E&D program that were targeted for implementation, and that had been defined to a level of detail that their interfaces with other systems could be examined. Such efforts as the Automated Terminal System (ATS), the Automated En Route Air Traffic Control (AERA), and the use of cockpit displays, were considered to be at a preliminary stage of development and were not considered in detail, but their potential impact was briefly noted where applicable. Evolutionary system improvements planned for widespread implementation by the Air Traffic Service (AAT) and the Airway Facilities Service (AAF) were also included, but limited application system patches were excluded.

This description considers the transition of the current ATC system to the time period when most of the major elements of the current E&D program will be implemented. Although it was difficult, and not essential to this document, to select specific implementation dates, the period covered roughly extends until the 1990 time frame.

The ATC system description is basically a set of ATC facility descriptions plus the interfaces that will have to be realized between them. Furthermore, the description is limited to normal mode operations intended to provide ATC services to users. As a result, certain functions are not considered. These functions include failure mode operations, administrative features, and system maintenance and record-keeping functions that are purely internal to the FAA. Some remote maintenance and monitoring improvements that are an integral part of future operational systems are included, however.

For a large part of the audience, the facility descriptions are informative and show how the elements can be made to interface and operate as a system. For others, such as the decision-makers, the descriptions will show how the ATC system is likely to evolve under the assumptions made. This document does not present a justification for the described program elements, nor does it examine system-wide alternatives to them. The document could be used, however, as an input to the process of deciding whether the programs should proceed as assumed or that some changes are needed to provide the capabilities desired by the decision-maker. The major assumptions stated as Open Items at end of Volume II may be of special interest to such decision-maker.

1.4 Approach

In developing the future ATC system description, steps were taken to first describe the various elements of the system and to then examine how the elements fit together as part of the overall system. More specifically, the first step was to identify the classes of facilities that would be examined individually. The facility breakdown used is shown in Table 1-1. The second step was to develop descriptions of each facility class based on current FAA plans and inputs from FAA personnel responsible for improving those subsystems. In the case of each facility class, a determination was made as to the functions to be performed, the inputs that were expected from other subsystems, and the ouptuts that were to be provided to other subsystems. Finally, the facility classes were examined collectively to ensure that there was a match between planned inputs and outputs. Cases where some additional examination may still be needed to assure compatibility were noted.

Facility descriptions were prepared for three time periods: Current, Near Term, and Far Term. The "Current System" was defined as consisting of those systems substantially in place by the end of calendar year 1978, including those system improvements that were funded for implementation in fiscal year 1977 or earlier years, but that were not completely operational by the end of calendar year of 1978. The Current System was used as the reference point for examining system changes and is presented only to a level of detail that is necessary to highlight system changes.

TABLE 1-1
ATC SYSTEM FACILITIES

FACILITY CLASS	FACILITIES INCLUDED	PRIMARY OPERATIONAL SERVICES PROVIDED
En Route Facilities	ARTCC	En Route ATC control and flight data handling of IFR flights.
TRACON Facilities	ARTS IIIA, ARTS III, ARTS II, TPX-42	Terminal ATC control of IFR and VFR arrivals, departures, and overflights.
Tower Facilities	Tower cabs, electronic ground surveillance, wind shear and wake vortex monitoring systems	Airport ATC control of IFR and VFR landings, takeoffs, and ground traffic.
System Command Center	ATC System Command Center	Central IFR traffic flow management and central ATC emergency command center.
Flight Service Facilities	FSS, Automated FSS, Flight Service Data Processing System, Aviation Weather Processor	Preflight and weather briefing, VFR flight plan filing and monitoring, IFR flight plan filing, emergency location and search and rescue coordination services, weather and flight condition data acquisition and dissemination.
Surveillance Facilities	Search Radar, ATCRBS, DABS, Joint-Use Weather Radar	Electronic surveillance of airborne aircraft via primary and secondary radar and radar surveillance of weather.
Navigation Facilities	VOR/DME, TACAN, RNAV, ILS, MLS, NDB	Electronic guidance for en route, terminal and landing operations.
Communication	FAA voice and data input, output, switching, signaling, transmission, receiving and distribution facilities	Voice and data communication linking the facilities cited above -- ground-ground and ground-air-ground.

The "Near Term System" was defined as the Current System modified to include those system improvements that could, according to current system plans, be substantially implemented by the end of calendar year 1982. Many of the anticipated Near Term improvements have already been approved for implementation and some have active procurement contracts. System improvements that have been approved for implementation have been noted in the documentation.

The "Far Term System" was defined as the Current System modified to include implementation of all system improvements in the current FAA E&D and operational service programs excluding non-CONUS, non-ATC, or long range research system improvements.

In several cases, it was found that firm plans as to the course-of-action to be pursued by the FAA have yet to be made due to the evolutionary nature of the ATC improvement program. In those cases, an attempt was made to select the course-of-action that the FAA seemed to be favoring and to describe the future system configuration accordingly. Major assumptions were then formulated and stated at the end of each chapter in Volume II. For the most part, the system descriptions contained in this Volume I and in the body of Volume II do not reflect those uncertainties, but instead describe the future system configurations as if they reflect firm FAA plans. The reader should recognize, however, that many plans are neither firm nor, in some cases, fully agreed to within the FAA. This degree of uncertainty of future improvements is a natural by-product of the evolutionary nature of the ATC system improvement process where the E&D program provides the tools for making improvements, but where the decision to implement them is deferred until the capabilities of the new improvements have been demonstrated and

until the implications of implementing them are fully understood. Thus, the "Near Term" and "Far Term" system descriptions should be viewed as reflecting the current thinking of those responsible for developing the new capability. They should not be viewed as reflecting a coordinated FAA plan.

1.5 Document Organization

The balance of this Volume I of this report is structured as follows: Section 2 identifies the various improvements which are expected at each of the ATC facilities, and summarizes how each functional area may actually evolve from today's configuration into the Near Term and the Far Term configurations. Section 3 presents a broader overview as to how the entire ATC system configuration would change in time, showing the evolution of connectivity and information flow between the various facilities that constitute the whole system. Section 4 presents a single thread description of how an IFR aircraft flying through high density airspace would be accommodated in today's system, in the Near Term System and in the Far Term System. The single thread description provides an added dimension to the overview of improvements since it cuts across facility lines. Section 5 presents the tentative implementation schedules that were assumed herein.

2. DESCRIPTION OF EVOLUTIONARY IMPROVEMENTS FOR EACH FACILITY CLASS

A summary of the various improvements that were assumed to be implemented in the Near Term and the Far Term Future ATC System Configurations are shown in Table 2-1. The table also identifies those improvements that have FAA and Department of Transportation approval for implementation. Most of the other Near Term and Far Term capabilities have been the subject of considerable development effort. Furthermore, it is the expectation of the FAA program managers that these capabilities would be implemented in the time frames indicated. A list of additional "potential" improvements is also included. These potential improvements include capabilities which are still in the conceptual stage or advanced development stage and have not yet been fully formulated to the point where they may be targeted for implementation in any of the time frames listed.

The improvements summarized in Table 2-1 are discussed in more detail in the following subsections. Each subsection describes the Near Term, Far Term and potential improvements for one of the facility classes. "Connectivity" diagrams are used in each subsection to describe the changes expected to take place in the capabilities, connectivity and information flow associated with each of the ATC facilities. In those diagrams, italics and heavy, broken lines were used to highlight the changes that would take place in the facilities if the system evolves as described herein.

2.1 En Route Facilities

Figure 2-1 depicts some of the major functions that are performed today within an Air Route Traffic Control Center (ARTCC). It also illustrates the connectivity and the information flow between the ARTCC and other FAA facilities.

FACILITY		NEAR TERM IMPROVEMENTS 1979-1982	FAR TERM IMPROVEMENTS POST-1982	OTHER POTENTIAL IMPROVEMENTS
ARTCC		● CONFLICT ALERT ENHANCEMENTS ● EN ROUTE MSAW ● EN ROUTE METERING ● FLIGHT PLAN CONFLICT PROBE ● DIRECT ACCESS RADAR CHANNEL (DARC)* ● CENTER WEATHER SURVICE UNIT (CWSU) ● REMOTE MAINTENANCE MONITOR SYSTEM (RMMS) PROCESSOR	● ELECTRONIC TABULAR DISPALY SUBSYSTEM (ETABS) ● DIGITIZED DISPLAY OF WEATHER (TURBULENCE) ● DABS/DATA LINK AVAILABLE ● DABS/ATARS ● CONFLICT RESOLUTION ADVISORY	● AUTOMATED EN ROUTE ATC (AERA) ● CONTROL MESSAGE AUTOMATION (CMA) ● REPLACEMENT/AUGMENTATION OF EN ROUTE COMPUTERS (9020, CDC) ● CWSU ACCESS TO A/G FREQUENCIES
TRACON (ARTS III)		● TERMINAL CONFLICT ALERT* ● SENSOR RECEIVER & PROCESSOR (SRAP) ● SEARCH RADAR TRACKING	● TERMINAL METERING & SPACING ● TERMINAL CONFLICT RESOLUTION ADVISORY ● TERMINAL INFORMATION PROCESSING SYSTEM (TIPS) ● DISPLAY OF DIGITIZED SEARCH RADAR & BEACON TARGET REPORTS ● DIGITIZED DISPLAY OF WEATHER (TURBULENCE) ● DABS/DATA LINK AVAILABLE ● ATC TOWER CONSOLIDATED DISPLAY (ACD) ● DABS/ATARS	● CMA ● AUTOMATED TERMINAL ATC ● ARTS III MAIN FRAME REPLACEMENT ● FULL DIGITAL ARTS DISPLAY (FDAD)
TOWER		● VORTEX ADVISORY SYSTEM (VAS)* ● LOW LEVEL WIND SHEAR ALERT* SYSTEM (LLWSAS)	● TIPS ● WAKE VORTEX AVOIDANCE SYSTEM (WVAS) ● ADVANCED WIND SHEAR DETECTION SYSTEM (AWSDS) ● TOWER AUTOMATED GROUND SURVEILLANCE (TAGS) ● AIRPORT SURFACE DETECTION EQUIPMENT (ASDE-3) ● ATC TOWER CONSOLIDATED DISPLAY (ACD) ● VISUAL CONFIRMATION (VICON) OF TAKEOFF CLEARANCE ● TOWER CAB DIGITAL DISPLAY (TCDD)	● AUTOMATED TERMINAL SERVICES (ATS)
ATCSCC		● CENTRAL FLOW CONTROL ENHANCEMENTS (MORE REAL TIME DATA AND MORE ACCURATE SIMULATIONS)* ● AUTOMATION OF CENTRAL ALTITUDE RESERVATION FUNCTION & AIRPORT RESERVATION OFFICE	● CENTRAL FLOW CONTROL ENHANCEMENTS	● CENTRALIZED FLIGHT PLANNING
FLIGHT SERVICE FACILITIES		<u>FLIGHT SERVICE DATA PROCESSING SYSTEM (FSDPS)/AUTOMATED FLIGHT SERVICE STATION (AFSS)</u> ● AUTOMATED SUPPORT TO SPECIALIST: NOTAM & WEATHER INFORMATION MAINTENANCE & RETRIEVAL, AND FLIGHT PLAN FILING ● ROUTE ORIENTED WEATHER RETRIEVAL ● AUTOMATED ALERTS ● DIGITIZED WEATHER RADAR AT 44 EFAS SITES	<u>FSDPS/AFSS</u> ● DIRECT USER ACCESS TERMINAL (DUAT) ● VOICE RESPONSE SYSTEM (VRS) ● SELECTIVE WEATHER RETRIEVAL ● IMPROVED GRAPHICS (AFOS) ● MULTIPLE WEATHER RADAR DISPLAY AT AFSS ● AUTOMATED EMERGENCY MESSAGE GENERATION ● AUTOMATED LOCATION CALCULATION <u>AVIATION WEATHER PROCESSOR (AWP)</u> ● CENTRALIZED MAINTENANCE & DISTRIBUTION OF WEATHER & FLIGHT CONDITIONS DATA BASE	● GRID DATA BASE WEATHER SYSTEM ● MORE CURRENT DATA ON UPPER AIR WIND/TEMPERATURE
SURVEILLANCE	EN ROUTE	● DUAL COMMON DIGITIZER (CD-2)* ● AIR ROUTE SURVEILLANCE RADAR (ARSR-3)*	● DABS/SURVEILLANCE, DATA LINK, ATARS ● ARSR WEATHER CHANNEL ● ARSR-4 ● MOVING TARGET DETECTOR (MTD) ● JOINT USE WEATHER RADAR ● ARSR/RMMS	
	TERMINAL		● DABS/SURVEILLANCE, DATA LINK, ATARS ● MOVING TARGET DETECTOR (MTD) ● AIRPORT SURVEILLANCE RADAR (ASR-9) ● ASR WEATHER CHANNEL ● JOINT USE WEATHER RADAR (FAA, NWS, AWS)	● LIMITED SURVEILLANCE RADAR
NAVIGATION		● SOLID STATE VORTAC*	● MICROWAVE LANDING SYSTEM (MLS) ● VORTAC/RMMS	● SATELLITE NAVIGATION ● TIME NAVIGATION
VOICE COMMUNICATIONS DATA COMMUNICATIONS		● SOLID STATE TRANCEIVERS FOR ALL A/G/A COMMUNICATIONS* ● RCAG/RMMS ● NADIN I* (CONSOLIDATE NASNET, AFTN AND SERVICE B, EXCEPT COMPUTER INTO NADIN 1) ● NADIN II (REPLACE DEDICATED CENTER/	● VOICE SWITCHING CONTROL SYSTEM (VSCS) FOR TERMINAL & ARTCC -- RCAG TONE CONTROL REPLACEMENT -- RADIO COMMUNICATIONS CONTROL SYSTEM (RCCS) -- GROUND/GROUND VOICE ● SMALL VOICE SWITCHING SYSTEM (SVSS) ● NEW GENERATION VHF/UHF ANTENNAS	● VSCS FOR FSS FACILITIES ● EVOLUTION INTO AN INTEGRATED SYSTEM, (RADIO, GROUND VOICE, DATA) ● SATELLITE COMMUNICATIONS

DATA COMMUNICATIONS	● NADIN I* (CONSOLIDATE NASNET, AFTN AND SERVICE B, EXCEPT COMPUTER INTO NADIN I) ● NADIN II (REPLACE DEDICATED CENTER/CENTER AND CENTER TO TRACON LINKS, ARTS III--ARTS III LINKS, REPLACE SERVICE A)	-- RADIO COMMUNICATIONS CONTROL SYSTEM (RCCS) -- GROUND/GROUND VOICE ● SMALL VOICE SWITCHING SYSTEM (SVSS) ● NEW GENERATION VHF/UHF ANTENNAS ● NADIN III (NADIN II + INTERFACE WITH ARTS THROUGH TIPS, PROVIDE CONNECTIVITY OF AWP/WMSC TO OTHER FSS FACILITIES)	VOICE, DATA) ● SATELLITE COMMUNICATIONS
AVIONICS		● BEACON COLLISION AVOIDANCE SYSTEM (BCAS) ● DABS TRANSPONDER ● ATARS DISPLAY ● DATA LINK DISPLAY ● MLS	● COCKPIT DISPLAY OF TRAFFIC INFORMATION (CDTI) ● HEAD UP DISPLAY (HUD)

*APPROVED BY THE FAA FOR IMPLEMENTATION

TABLE 2-1
SUMMARY OF ATC SYSTEM IMPROVEMENTS

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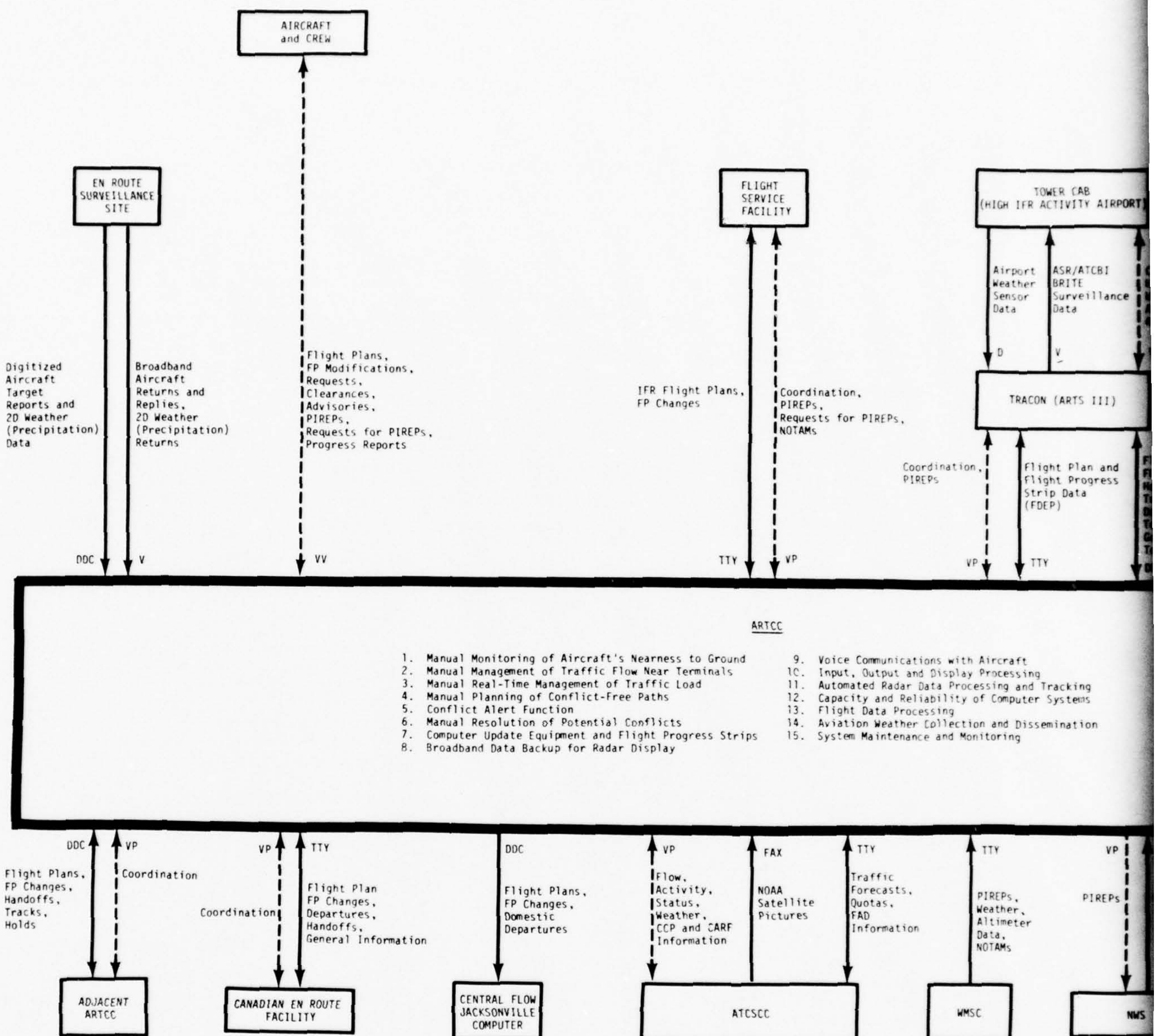

AIRCRAFT and CREW
EN ROUTE SURVEILLANCE SITE
FLIGHT SERVICE FACILITY
TOWER CAB (HIGH IFR ACTIVITY AIRPORT)
Airport Weather Sensor Data
D
ASR/ATCBI BRITE Surveillance Data
V
TRACON (ARTS III)
Digitized Aircraft Target Reports and 2D Weather (Precipitation) Data
Broadband Aircraft Returns and Replies, 2D Weather (Precipitation) Returns
Flight Plans, FP Modifications, Requests, Clearances, Advisories, PIREPs, Requests for PIREPs, Progress Reports
IFR Flight Plans, FP Changes
Coordination, PIREPs, Requests for PIREPs, NOTAMs
Coordination, PIREPs
Flight Plan and Flight Progress Strip Data (FDEP)
DDC
V
VV
TTY
VP
VP
TTY
ARTCC
1. Manual Monitoring of Aircraft's Nearness to Ground
2. Manual Management of Traffic Flow Near Terminals
3. Manual Real-Time Management of Traffic Load
4. Manual Planning of Conflict-Free Paths
5. Conflict Alert Function
6. Manual Resolution of Potential Conflicts
7. Computer Update Equipment and Flight Progress Strips
8. Broadband Data Backup for Radar Display
9. Voice Communications with Aircraft
10. Input, Output and Display Processing
11. Automated Radar Data Processing and Tracking
12. Capacity and Reliability of Computer Systems
13. Flight Data Processing
14. Aviation Weather Collection and Dissemination
15. System Maintenance and Monitoring
DDC
VP
Flight Plans, FP Changes, Handoffs, Tracks, Holds
Coordination
VP
TTY
Coordination
Flight Plan FP Changes, Departures, Handoffs, General Information
DDC
Flight Plans, FP Changes, Domestic Departures
VP
Flow, Activity, Status, Weather, CCP and CARF Information
FAX
NOAA Satellite Pictures
TTY
Traffic Forecasts, Quotas, FAD Information
TTY
PIREPs, Weather, Altimeter Data, NOTAMs
VP
PIREPs
ADJACENT ARTCC
CANADIAN EN ROUTE FACILITY
CENTRAL FLOW JACKSONVILLE COMPUTER
ATCSCC
WMSC
NWS

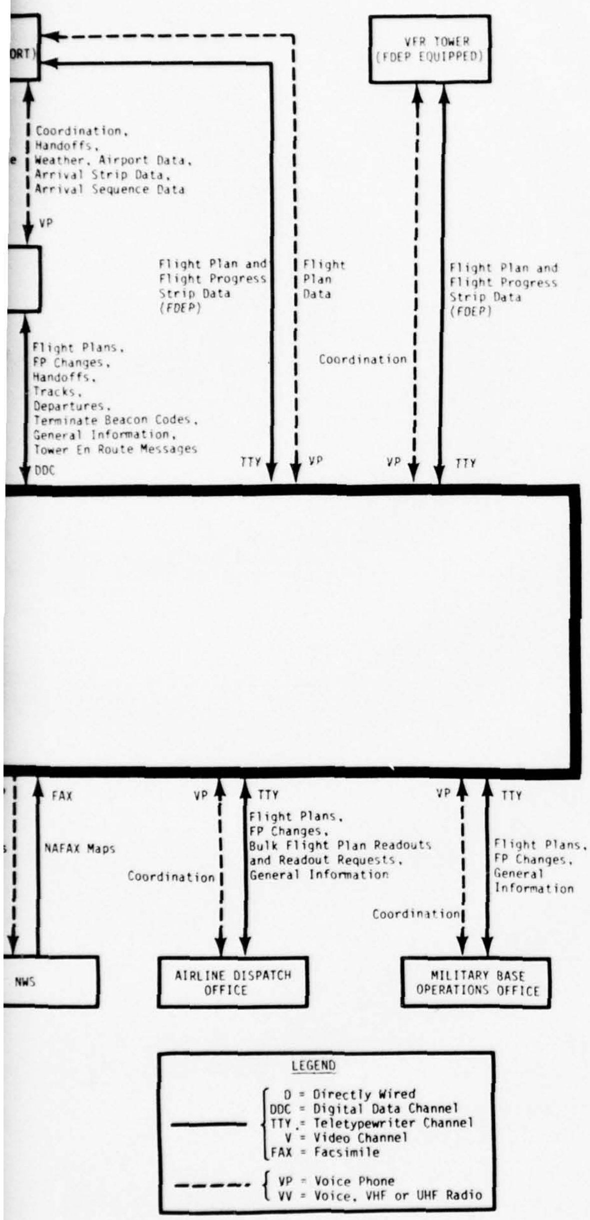
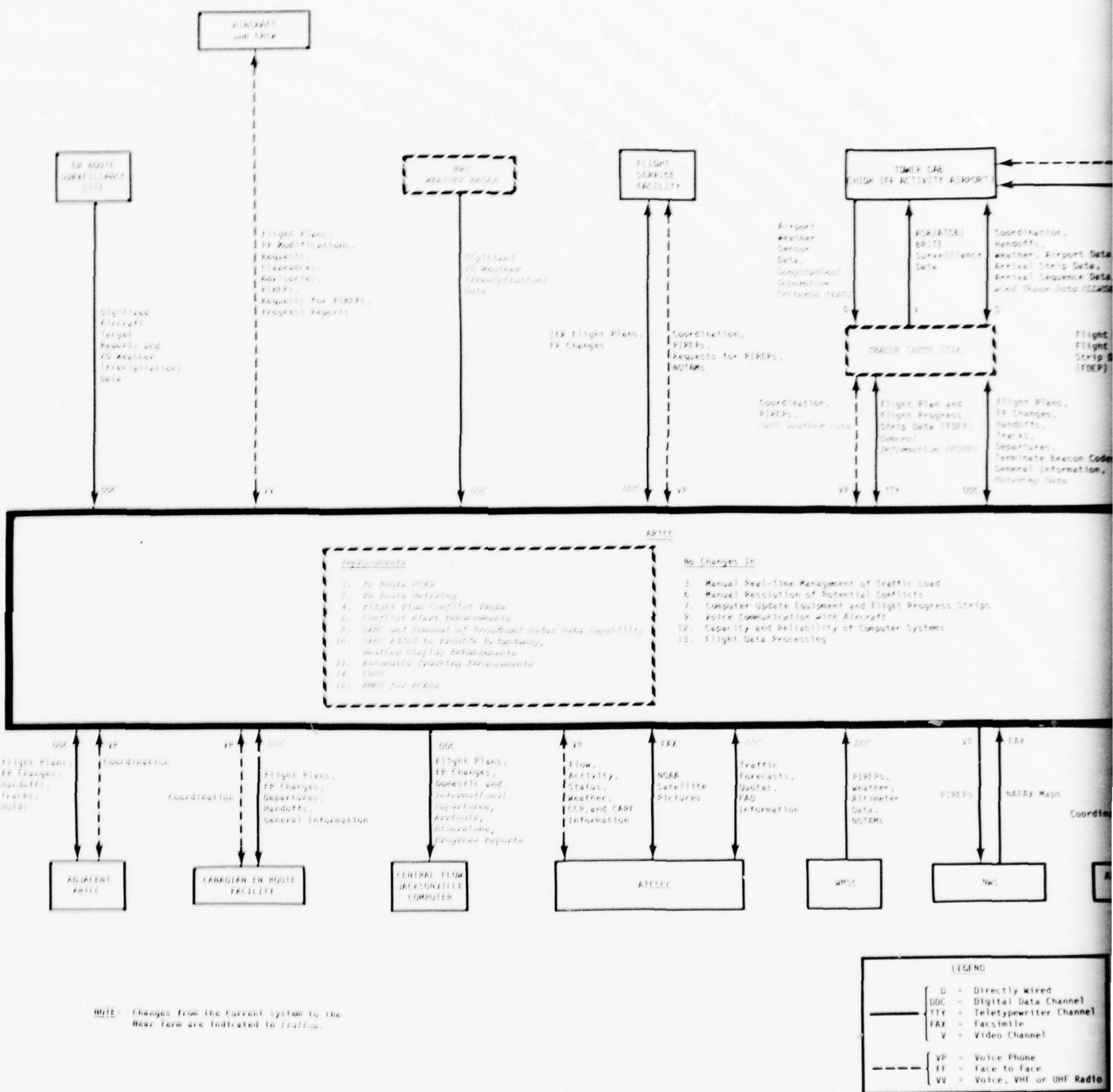


FIGURE 2-1
CAPABILITIES AND CONNECTIVITY OF CURRENT EN ROUTE FACILITIES

2.1.1 Near Term Improvements

Major changes that are expected to occur in the ARTCC in the Near Term are illustrated in Figure 2-2. These changes include the addition of new automation aids to provide the controller with enhancements to the separation assurance function (Conflict Alert) and avoidance of violation of safe altitudes (En Route MSAW). Currently, Conflict Alert alerts the controller if two IFR aircraft are likely to approach one another so closely that separation standards will be violated. The conflict alert capability is to be enhanced to provide alerts when an IFR aircraft and a VFR aircraft equipped with Mode C are projected to approach one another too closely. The En Route Minimum Safe Altitude Warning (EMSAW) would provide controllers with automated warnings when aircraft are in danger of violating established minimum safe altitudes. Currently, the controllers manually compare aircraft altitudes with minimum safe altitudes in their airspace. Instead, EMSAW would use computer software to provide that comparison and would display warnings of potential violations.

Two new automation aids to assist controllers in the planning function are expected to be implemented in this time frame. These are En Route Metering and Flight Plan Conflict Probe (FPCP). En Route Metering automation would provide the controller with estimated and desired arrival times at coordination (handoff) fixes. It would also provide advisories to improve spacing, sequencing, and delay management. En Route Metering is also expected to consider profile descent paths designed for maximum fuel efficiency. Flight Plan Conflict Probe (FPCP) would provide controllers with an automated capability of anticipating potential conflicts many minutes



AIRCRAFT
EN ROUTE SURVEILLANCE SITE
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Coordination, Handoffs, Weather, Airport Data, Arrival Strip Data, Arrival Sequence Data,
D
V
D
Flight
Flight
Strip
(FDEP)
Coordination, PIREPs,
Flight Plan and Flight Progress Strip Data (FDEP)
Flight Plans, FP Changes, Handoffs, Tracks, Departures, Terminate Beacon Code, General Information,
VP
TTY
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ARTCC
Improvements
No Changes In:
3. Manual Real-Time Management of Traffic Load
6. Manual Resolution of Potential Conflicts
7. Computer Update Equipment and Flight Progress Strips
9. Voice Communication with Aircraft
12. Capacity and Reliability of Computer Systems
13. Flight Data Processing
DDC
VP
Flight Plans, FP Changes, Handoffs, Tracks, Holds
Coordination
VP
Coordination
Flight Plans, FP Changes, Departures, Handoffs, General Information
DDC
Flight Plans, FP Changes, Domestic and
VP
Flow, Activity, Status, Weather, CCP, and CARF Information
FAX
NOAA Satellite Pictures
Traffic Forecasts, Quotas, FAD Information
PIREPs, Weather, Altimeter Data, NOTAMs
VP
PIREPs
FAX
NATAX Maps
Coordin
ADJACENT ARTCC
CANADIAN EN ROUTE FACILITY
CENTRAL FLOW JACKSONVILLE COMPUTER
ATCSCC
WMSC
NWS
LEGEND
D - Directly Wired
DDC - Digital Data Channel
TTY - Teletypewriter Channel
FAX - Facsimile
V - Video Channel
VP - Voice Phone
FF - Face to Face
VV - Voice, VHF or UHF Radio
NOTE: Changes from the current system in the Near Term are indicated in italics.

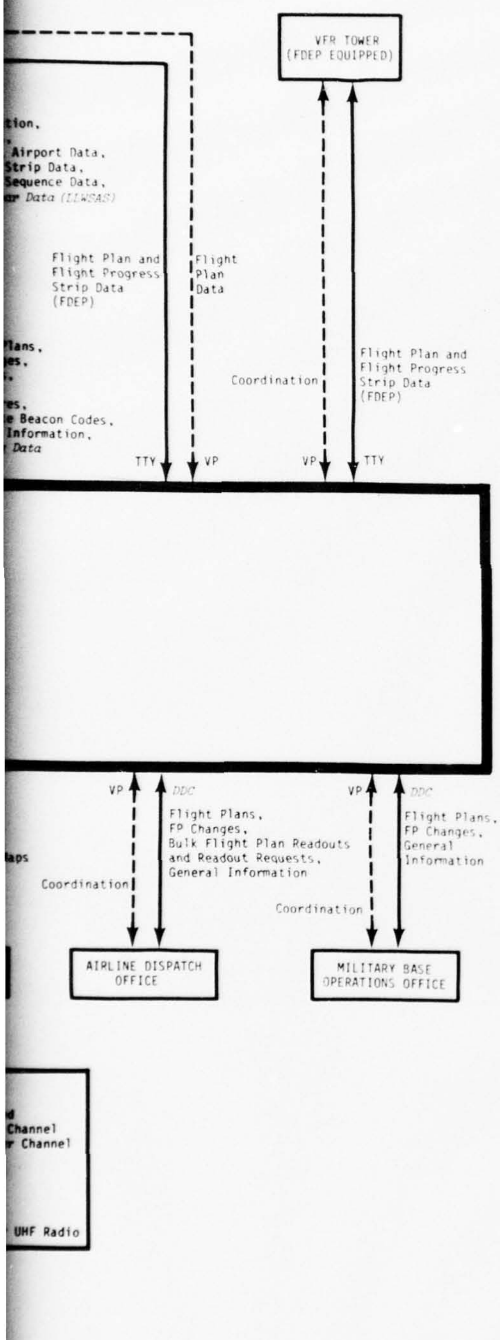


FIGURE 2-2
EXPECTED CAPABILITIES AND CONNECTIVITY OF EN ROUTE FACILITIES IN THE NEAR TERM

in advance. The conflict probe would be automatically triggered by flight plan amendments and upon handoff acceptance. Additionally, the controller could manually initiate the conflict probe. If conflicts are anticipated, the controller would make tentative changes in flight plans and repeat the probing and changing of flight plans until a conflict-free path is found.

A new hardware/software backup capability that will be added in the Near Term to enhance the continuity of operations of the en route center is the Direct Access Radar Channel (DARC) capability. DARC will provide the radar controller with displays of aircraft targets, data blocks, maps and weather in the event of unavailability of the Central Computer Complex (CCC) or the Data Entry and Display System (DEDS). DARC would also allow some level of radar data processing to be operational on a 24-hour-per-day basis while permitting maintenance of other parts of the automation system and checkout of new programs.

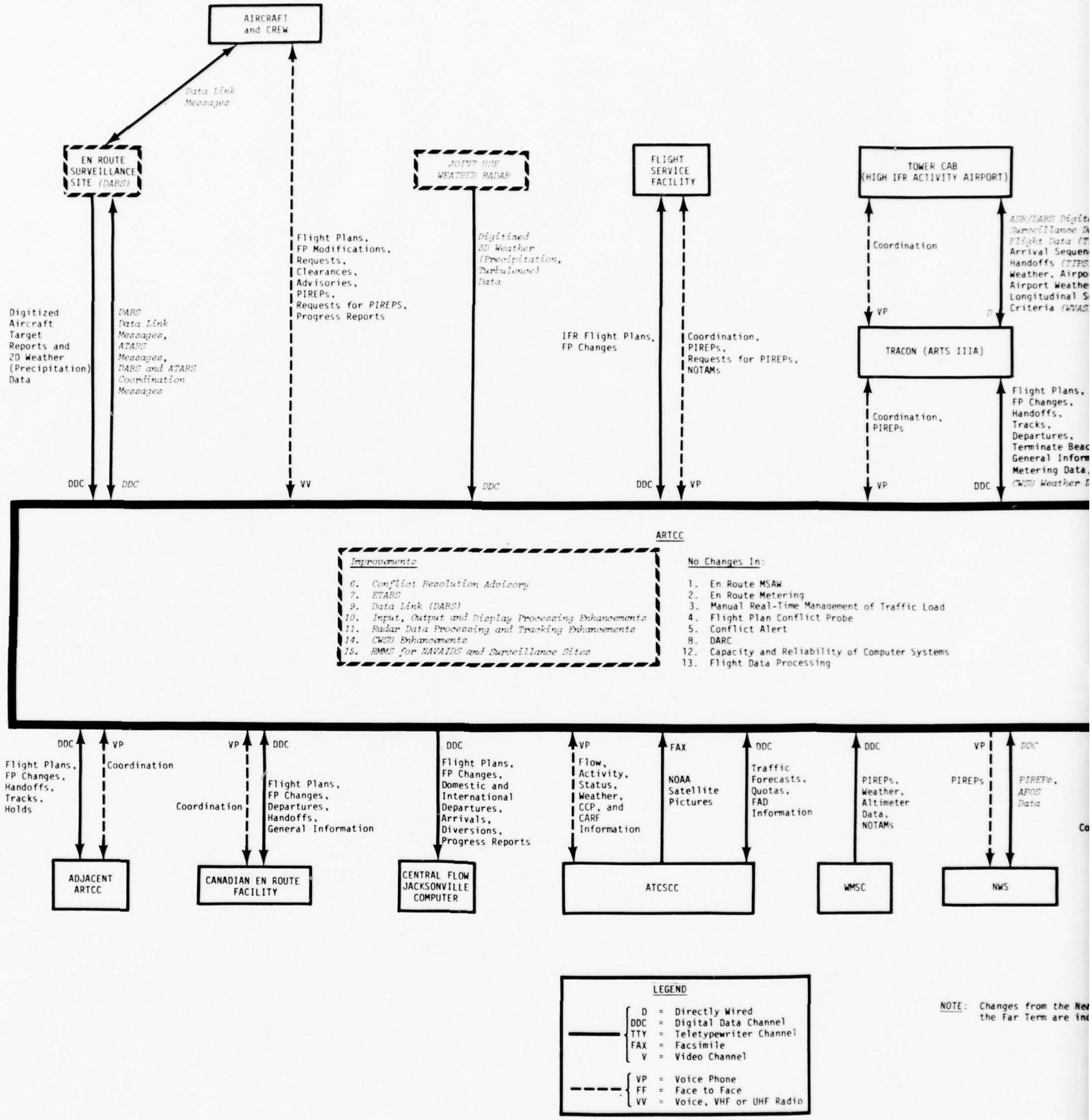
A Center Weather Service Unit (CWSU) would be established at the ARTCC to be manned by a meteorologist who would be provided with an operating position and supporting aids. The main functions of the CWSU include providing interpretation of aviation weather with emphasis on hazardous conditions, and to achieve more coordination and organized dissemination of weather information. According to the Aviation Weather System program plan, which is currently undergoing coordination within the FAA, the meteorologist at the CWSU would be provided with a PVD with access to the ARTCC radars, access to the NWS weather radars, and facsimile displays of NWS weather information including the NOAA satellite pictures. The NWS weather radar information supplied to the CWSU is digitized and three-dimensional (i.e., provides azimuth, range, and altitude).

In addition, the meteorologist would be provided with the capability to communicate by voice with air traffic controllers and FSS specialists within the Center's area or within airspace adjoining that of the center.

It is anticipated that the ARTCC would be the host facility for a remote maintenance monitoring central processor that would be implemented in the near term as part of the Remote Maintenance Monitor System (RMMS). It is intended that this processor would service the Remote Communications Air-Ground (RCAG) facilities, the navigation facilities, and the radar surveillance facilities. However, in the near term, only the RCAGs would be serviced. The RMMS would maximize the utilization of personnel resources and enhance system availability. More specifically, the capabilities obtained would be remote monitoring of equipments and alarms, remote certification, trend analysis, automated recordkeeping, and remote control of backup power sources.

2.1.2 Far Term Improvements

Figure 2-3 highlights the major changes that are expected to occur in the ARTCC in the Far Term. First, the planning and flight data handling function would be enhanced by the introduction of the Electronic Tabular Display Subsystem (ETABS) which would provide controllers with efficient means of communicating with and displaying the flight data base by using simplified data updating and data entry procedures/devices. This eliminates the handling of flight progress strips and reduces controller workload. The planning function would be further enhanced by the eventual integration of En Route Metering with Flight Plan Conflict Probe so that metering instructions would be conflict-free.



AIRCRAFT and CREW
Data Link Messages
EN ROUTE SURVEILLANCE SITE (DABS)
JOINT USE WEATHER RADAR
FLIGHT SERVICE FACILITY
TOWER CAB (HIGH IFR ACTIVITY AIRPORT)
Digitized Aircraft Target Reports and 2D Weather (Precipitation) Data
DABS Data Link Messages, ATARS Messages, DABS and ATARS Coordination Messages
Flight Plans, FP Modifications, Requests, Clearances, Advisories, PIREPs, Requests for PIREPS, Progress Reports
Digitized 3D Weather (Precipitation, Turbulence) Data
IFR Flight Plans, FP Changes
Coordination, PIREPs, Requests for PIREPs, NOTAMs
Coordination
VP
D
TRACON (ARTS IIIA)
Coordination, PIREPs
Flight Plans, FP Changes, Handoffs, Tracks, Departures,
DDC
DDC
VV
DDC
DDC
VP
VP
DDC
ARTCC
Improvements
6. Conflict Resolution Advisory
7. ETABS
9. Data Link (DABS)
10. Input, Output and Display Processing Enhancements
11. Radar Data Processing and Tracking Enhancements
14. CWSU Enhancements
15. RMMS for NAVAIDS and Surveillance Sites
No Changes In:
1. En Route MSAW
2. En Route Metering
3. Manual Real-Time Management of Traffic Load
4. Flight Plan Conflict Probe
5. Conflict Alert
8. DARC
12. Capacity and Reliability of Computer Systems
13. Flight Data Processing
DDC
VP
Flight Plans, FP Changes, Handoffs, Tracks, Holds
Coordination
VP
DDC
Coordination
Flight Plans, FP Changes, Departures, Handoffs, General Information
DDC
Flight Plans, FP Changes, Domestic and International Departures, Arrivals, Diversions, Progress Reports
VP
Flow, Activity, Status, Weather, CCP, and CARF Information
FAX
NOAA Satellite Pictures
DDC
Traffic Forecasts, Quotas, FAD Information
DDC
PIREPs, Weather, Altimeter Data, NOTAMs
VP
PIREPs
DDC
PIREPs, AFOS Data
ADJACENT ARTCC
CANADIAN EN ROUTE FACILITY
CENTRAL FLOW JACKSONVILLE COMPUTER
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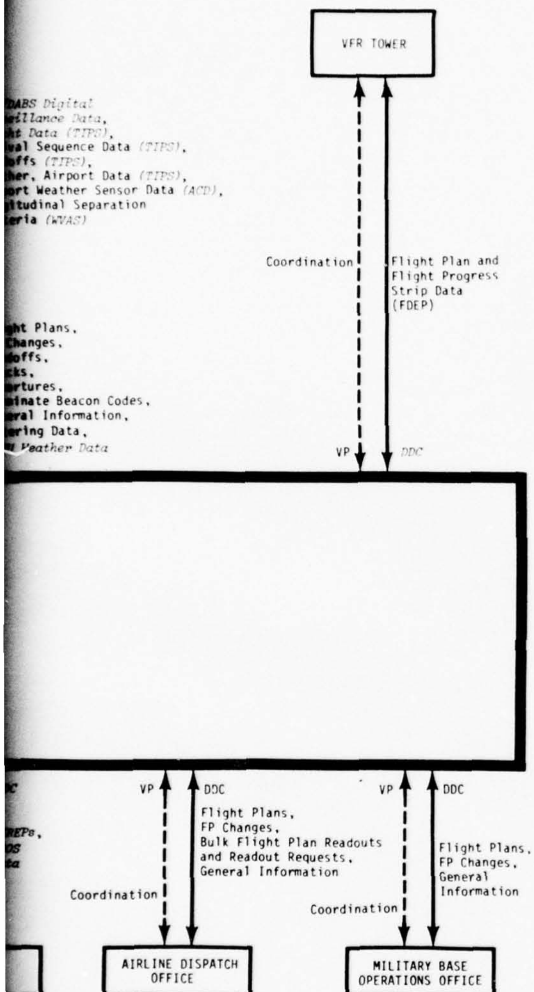
NOTE: Changes from the
the Far Term are



the Near Term system to
are indicated in *italics*,

FIGURE 2-3
EXPECTED CAPABILITIES AND CONNECTIVITY OF EN ROUTE FACILITIES IN THE FAR TERM

2

Another expected improvement is the availability to the en route controller of digitized display of 3D weather turbulence information. This would be made possible with the implementation of the Joint Use (FAA/NWS) Weather Radars which would use high resolution pencil beams and sophisticated doppler processing techniques. The Conflict Resolution Advisory function would be added to provide solutions to conflicts and to recommend them to the controller on his display devices. The Automated Traffic Advisory and Resolution Service (ATARS) would also be made available to provide pilots with proximity warnings and collision avoidance messages as a back-up to Conflict Alert if threat of collision persists after a Conflict Alert has been issued. The ATARS messages would be provided by the DABS/data link to equipped aircraft, and the appropriate en route controller would be advised of the ATARS messages sent to the aircraft under his control. Other uses of the data link by en route ATC have not been fully defined as yet, but the potential that the data link holds for the transmission of various ATC and advisory messages and for increasing controller productivity has been recognized.

Also in the Far Term, the RMMS processor, in addition to handling the RCAG remote maintenance monitoring requiements, would also handle similar requirements for en route surveillance radars and for en route navigation facilities as well. Thus, the RMMS processor would become a central facility for remote maintenance monitoring.

2.1.3 Other Potential Improvements

Other possible changes include the Automated En Route ATC (AERA) program, which aims at exploring the potential for automating the routine aspects of generating conflict-free flight paths,

monitoring flight progress and planning sector clearances. Another potential improvement is Control Message Automation (CMA) which would provide the link between the en route processor and the data link. CMA is the system that handles functions such as formatting, message routing, and priorities for data link messages. CMA would handle messages that may be generated through such subsystems as Conflict Alert, Conflict Resolution Advisory, ETABS, etc. All three systems, AERA, CMA, and data link or variations of them may be required to achieve the desired capability of the automated generation and delivery of some ATC and advisory messages. Another potential change is the replacement/augmentation of the en route computers (9020, CDC). This point continues to be raised as air traffic volume increases, as software capabilities are added to the en route system threatening to exceed current hardware limitations, and as the equipment grows older and as the maintenance costs begin to rise. There is general agreement within FAA management that improvements in this area are required, and various investigations and studies are currently underway to determine a desirable course of action.

The Center Weather Service Unit (CWSU) may be provided with access to the air-ground communications frequencies available at the en route center. The meteorologist would then be capable of monitoring pilot to controller communications vis-a-vis weather and would be capable of directly communicating with the pilot for the acquistion of more specific weather information. The feasibility and cost considerations of providing this capability to the CWSU are currently under discussion within the FAA.

2.2 TRACON Facilities

Figure 2-4 illustrates some of the major functions that are performed today within the ARTS III TRACON facilities. The figure

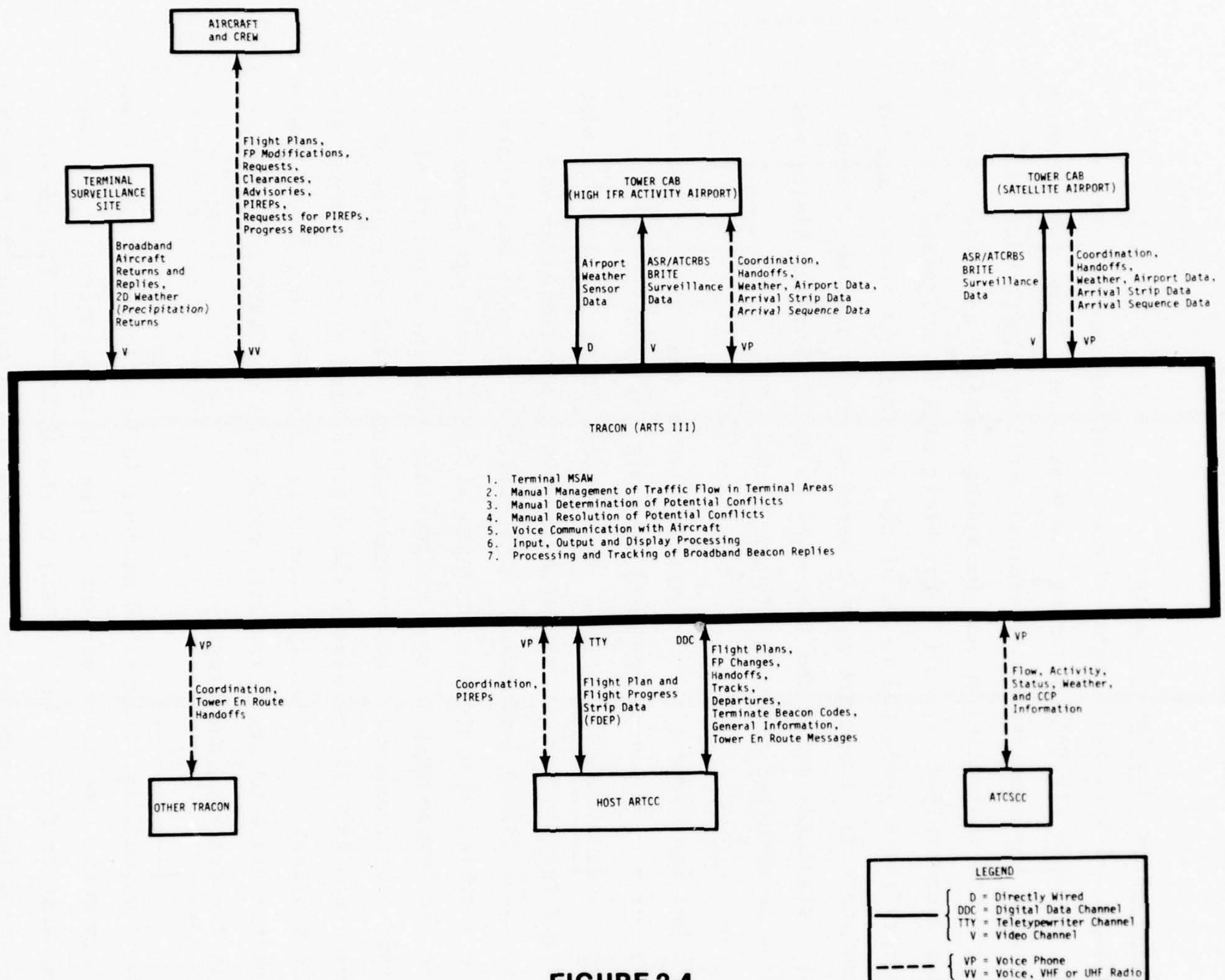


FIGURE 2-4
CAPABILITIES AND CONNECTIVITY OF CURRENT TRACON FACILITIES

In addition to improvements in ARTS III facilities, other lower level TRACON facilities are designated for some level of automation. ARTS II automation equipment would be implemented in some of those facilities. ARTS II equipment provides displays of beacon and search radar target reports, and display of data blocks associated with beacon reports. Unlike ARTS III however, the ARTS II equipment does not provide automatic tracking.

2.2.2 Far Term Improvements

Figure 2-6 shows some of the major improvements expected to occur in the TRACON facilities in the Far Term. Automation aids in Metering and Spacing (M&S) would be provided in the ARTS III terminal facilities to assist the approach controller in achieving desired spacing and sequencing to improve accuracy in the delivery of aircraft to the runway threshold and thus aid in increasing airport capacity. Metering and Spacing is expected to include consideration of profile descent paths (i.e., paths designed for maximum fuel efficiency) and to incorporate a capability for handling multiple runways, departures, arrivals, tower en route and VFR aircraft. The final design of the implementable M&S is expected to provide the En Route Metering algorithm with sequencing information, arrival times at feeder fixes, or (possibly) terminal acceptance rate.

One of the improvements expected for all TRACONs including ARTS II and TPX-42 facilities, is the implementation of the Terminal Information Processing System (TIPS), which would accept, process, distribute, and display flight data for the terminal area. The use of TIPS would eliminate the use of the Flight Data Entry and Printout (FDEP) equipment, and the associated flight progress strips in approach control facilities and their associated tower cabs. The TRACON controllers would have

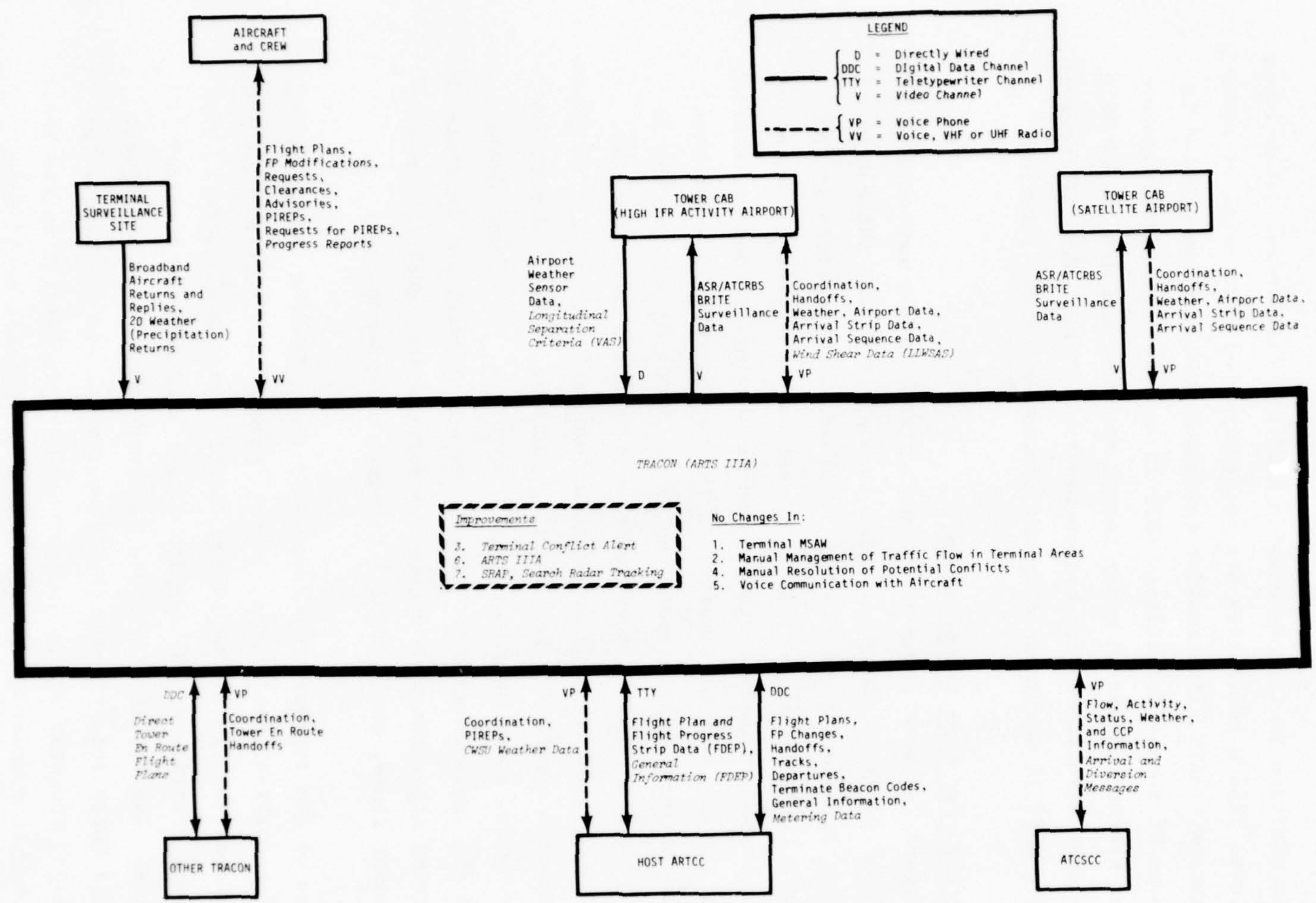
also illustrates the connectivity and the information flow between these TRACONs and other FAA facilities.

2.2.1 Near Term Improvements

Figure 2-5 highlights major changes that are expected to occur in the ARTS III TRACON during the Near Term. These improvements include implementation of Terminal Conflict Alert which will alert the controller to any impending conflict situation involving a controlled aircraft. The alert will be triggered when aircraft are projected to be within a relatively close range of one another. The alert is not based on the violation of separation standards as is the case with En Route Conflict Alert, nor does it make use of stored flight plans.

Another improvement is the introduction of Search Radar Tracking. Currently only beacon equipped aircraft are tracked based on their beacon target reports. In the Near Term, the search radar target reports will be digitized by the Sensor Receiver and Processor (SRAP) equipment. This digitization will facilitate the tracking of nonbeacon equipped aircraft which are known to the ATC System only through reflections from the aircraft of "raw" electromagnetic radar transmissions. SRAP will also offload from ARTS III processor the digitization of the beacon target replies. Additionally, SRAP will correlate search and beacon returns and send the correlated reports to the ARTS III processor for tracking and display.

The availability of improved weather information is another change which would come about because of the implementation of the Center Weather Service Unit (CWSU) in the ARTCC. The CWSU would become a focal point in obtaining and disseminating Pilot Weather Reports (PIREPs) and weather reports from the TRACON, as well as from other ATC facilities.



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

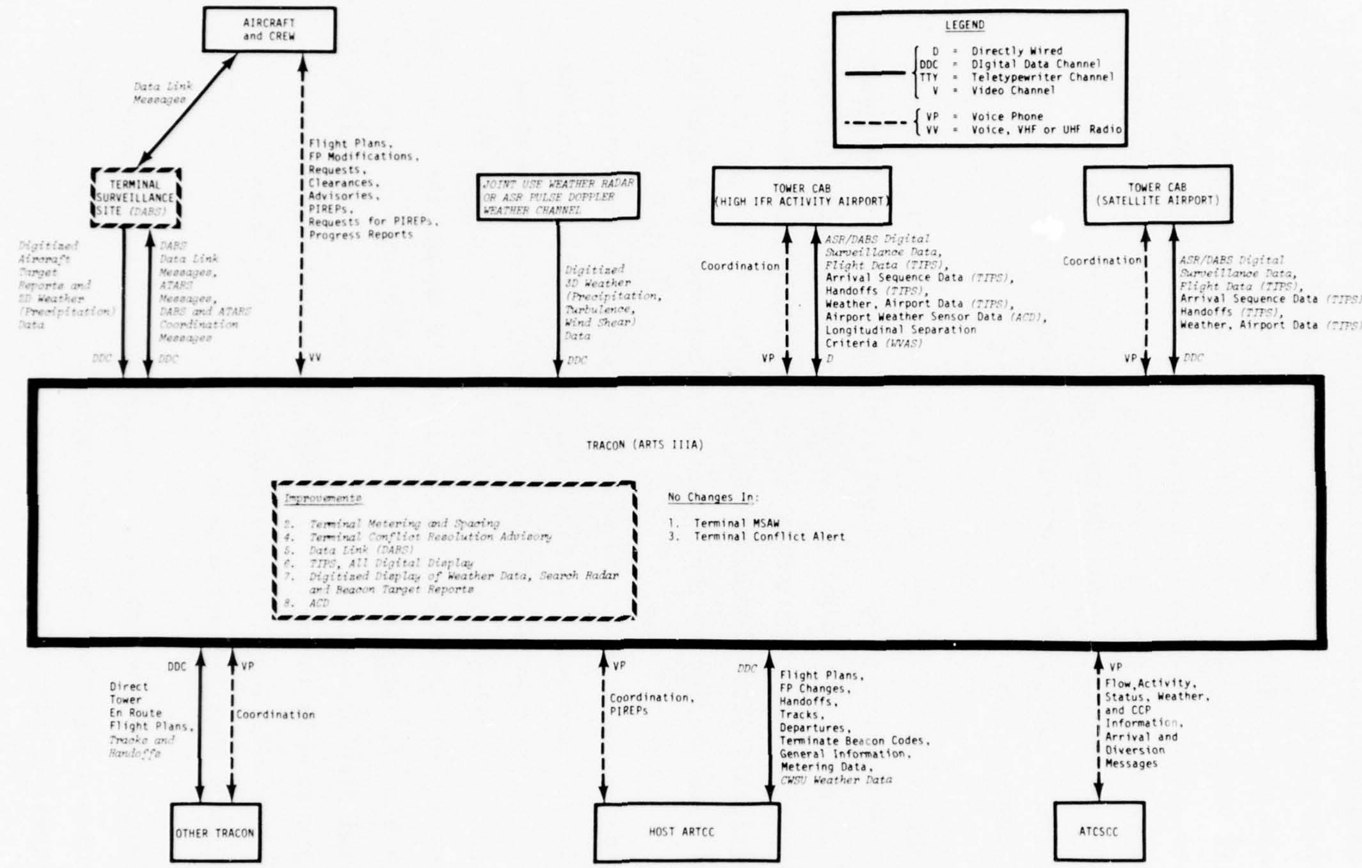
FIGURE 2-5
EXPECTED CAPABILITIES AND CONNECTIVITY OF TRACON FACILITIES IN THE NEAR TERM

In addition to improvements in ARTS III facilities, other lower level TRACON facilities are designated for some level of automation. ARTS II automation equipment would be implemented in some of those facilities. ARTS II equipment provides displays of beacon and search radar target reports, and display of data blocks associated with beacon reports. Unlike ARTS III however, the ARTS II equipment does not provide automatic tracking.

2.2.2 Far Term Improvements

Figure 2-6 shows some of the major improvements expected to occur in the TRACON facilities in the Far Term. Automation aids in Metering and Spacing (M&S) would be provided in the ARTS III terminal facilities to assist the approach controller in achieving desired spacing and sequencing to improve accuracy in the delivery of aircraft to the runway threshold and thus aid in increasing airport capacity. Metering and Spacing is expected to include consideration of profile descent paths (i.e., paths designed for maximum fuel efficiency) and to incorporate a capability for handling multiple runways, departures, arrivals, tower en route and VFR aircraft. The final design of the implementable M&S is expected to provide the En Route Metering algorithm with sequencing information, arrival times at feeder fixes, or (possibly) terminal acceptance rate.

One of the improvements expected for all TRACONs including ARTS II and TPX-42 facilities, is the implementation of the Terminal Information Processing System (TIPS), which would accept, process, distribute, and display flight data for the terminal area. The use of TIPS would eliminate the use of the Flight Data Entry and Printout (FDEP) equipment, and the associated flight progress strips in approach control facilities and their associated tower cabs. The TRACON controllers would have



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

FIGURE 2-6
EXPECTED CAPABILITIES AND CONNECTIVITY OF TRACON FACILITIES IN THE FAR TERM

available to them full flight plan data on separate TIPS displays. Additional simplified information may be made available to the controller on his PVD. The tower controllers would also communicate with TIPS via tabular displays and data entry devices. Thus, TIPS would provide a means of communications between devices within the tower or TRACON facilities, between towers, and between towers and TRACONs. Furthermore, TIPS would provide the communications medium between TRACONs and their host ARTCCs. For example, weather information edited by the CWSU would now be provided through TIPS.

Another anticipated improvement is the eventual interface between Metering and Spacing (M&S) and Conflict Alert in order to ensure that M&S advisories provided to the controller are conflict-free. Furthermore, Conflict Resolution Advisory would be implemented to automatically provide recommended solutions to controllers that have been alerted to the potential occurrence of a conflict.

In today's system, a broadband display of aircraft and weather targets is provided together with digital data blocks and lists of aircraft. An expected change in this area would come about by the use of an all-digital display of aircraft targets (beacon or search) on the TRACON PVD. In addition to making the displayed information more distinct and less variable (no fading), the all-digital display would facilitate the display of more digital information than is currently possible. It would also provide the user with additional selectivity and filtering capability over and above what is currently available.

The all-digital TRACON PVD would be used to provide the controller with a digitized three dimensional (i.e., range, azimuth and altitude) display of weather turbulence. This capability

would be made available through the use of inputs from the Joint Use Weather Radars where coverage permits or by the implementation of the ASR Pulse Doppler Weather Channel.

The DABS/data link would also be made available not only for the ATARS services but also for various other uses including the automated generation and delivery of ATC messages in the terminal area in a fashion similar to that envisioned in the AERA programs for advanced en route automation. ATARS would provide the pilot with proximity warnings and collision avoidance messages as a backup to Conflict Alert if a collision threat persists after a Conflict Alert has been issued. The appropriate terminal controller would be advised of the ATARS messages sent to the aircraft under his control.

The currently numerous status displays associated with airport communications, navigation, and surveillance facilities would be replaced by the ATC Tower Consolidated Display (ACD) which integrates and consolidates the status data into one display. Weather sensor indicators (wind, temperature, barometric pressure, etc.) would also be incorporated into the consolidated display. It is expected that the terminal processor that would handle the consolidated display functions, would also incorporate some remote maintenance and monitoring functions.

2.2.3 Other Potential Improvements

It is anticipated that future advanced automation in the terminal facilities would be somewhat along the line of En Route Automation (AERA) and thus include the automation of the routine aspects of generating conflict-free flight paths, monitoring the flight progress, and planning and delivering the clearances via data link. Associated with advanced automation is Control Message

Automation (CMA) which provides the connectivity between the TRACON computers and the automation systems on the one hand and the data link on the other. CMA could, for instance, handle possible data link traffic generated by Metering and Spacing, MSAW, Conflict Alert or any other ATC or advisory messages that are desirable to transmit to the pilot.

Another potential change is the replacement of the ARTS III main frame computer capability since it represents older technology that may not provide the most efficient means of absorbing all of the new automation programs discussed above.

Since it is expected that an all-digital display capability would be implemented in the Far Term system, a period of transition is foreseen where both analog and digital display capabilities might be used. In order to facilitate this transition, the use of a Full Digital ARTS Display (FDAD) capability is being investigated. FDAD would display analog as well as digital information.

Various functional enhancements such as conflict alert, MSAW, or Automatic Tracking, have been considered for application in the ARTS II facilities, but they are not being actively developed at this point.

2.3 Tower Facilities

This section is concerned with those facilities that handle airport ATC control of IFR and VFR landings, takeoffs and ground control. Figure 2-7 highlights some of the major functions that are currently performed within the tower cab facilities. The figure also illustrates the connectivity and the information flow between the tower cab and other FAA facilities.

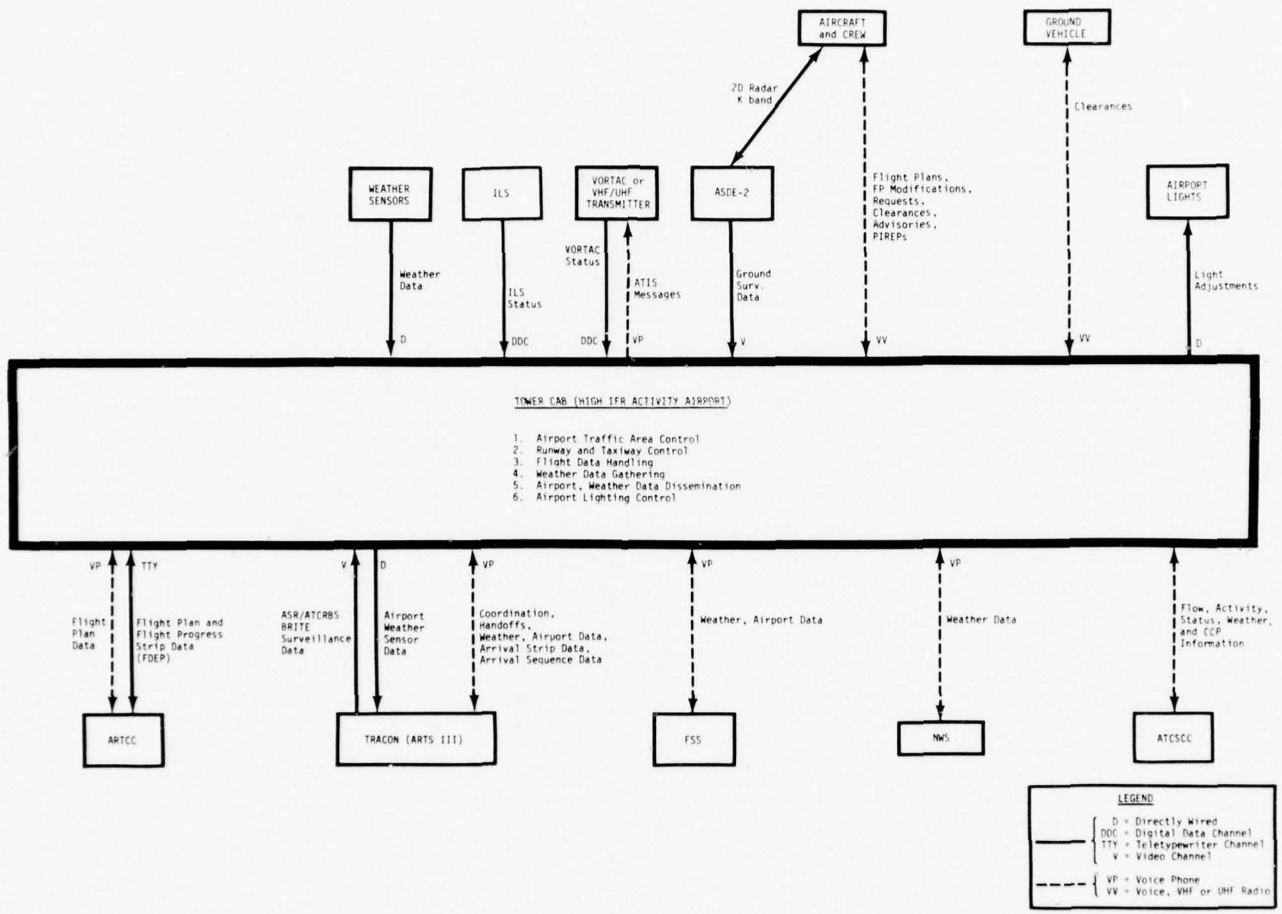


FIGURE 2-7
CAPABILITIES AND CONNECTIVITY OF CURRENT TOWER FACILITIES
(HIGH IFR ACTIVITY AIRPORTS)

2.3.1 Near Term Improvements

Major changes that are expected to occur in this time frame are illustrated in Figure 2-8. These improvements include the installation of the Vortex Advisory System (VAS) at some of the high IFR activity airports. The sensors of this system are to be mounted on towers located in the vicinity of the middle markers and would measure the wind direction and speed at that point. This information will be used as input data to a VAS processor which would then indicate whether the wake vortex dissipation conditions justify reducing the longitudinal separation standards between successive aircraft (and therefore increasing runway throughput). Tower controllers would be informed by means of VAS displays located in the tower cab. The same VAS information would also be communicated to the TRACON controllers via VAS displays.

It is anticipated that the Low Level Wind Shear Alert System (LLWSAS) would be implemented at most of the high IFR activity airports. This system would detect (at ground level) the vector difference in wind velocity between a centrally located sensor and peripheral sensors. This vector difference would be an indication of wind shear conditions due to updrafts and downdrafts. An alert would be declared and displayed in the tower cab when this vector difference exceeds a certain threshold. Wind shear data would be forwarded to the TRACON from the tower by controller voice communication.

2.3.2 Far Term Improvements

Some of the major changes that are expected to occur in the tower facilities in the Far Term are depicted in Figure 2-9. First, there would be significant improvements in the handling of flight data by the implementation of the Terminal Information

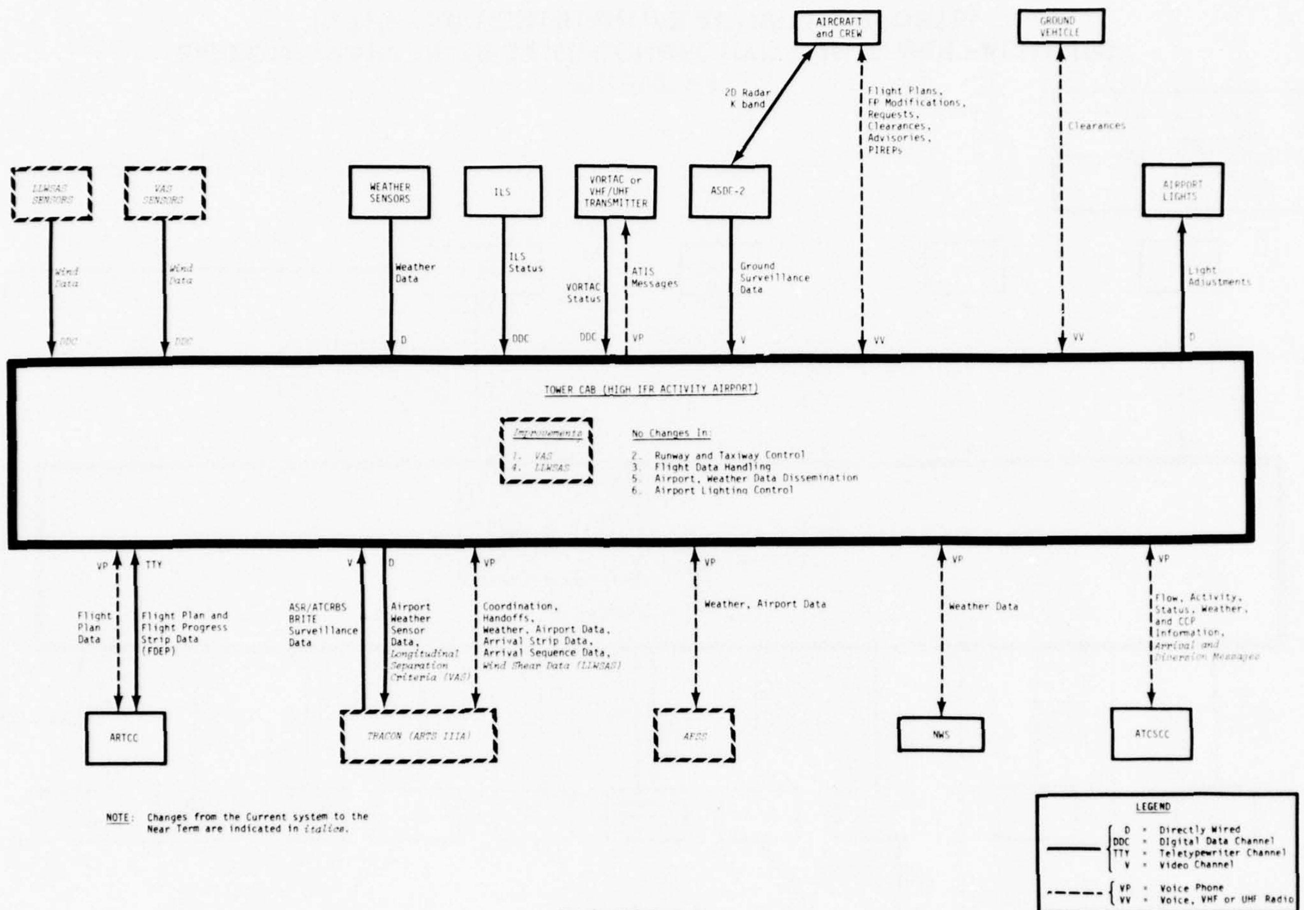
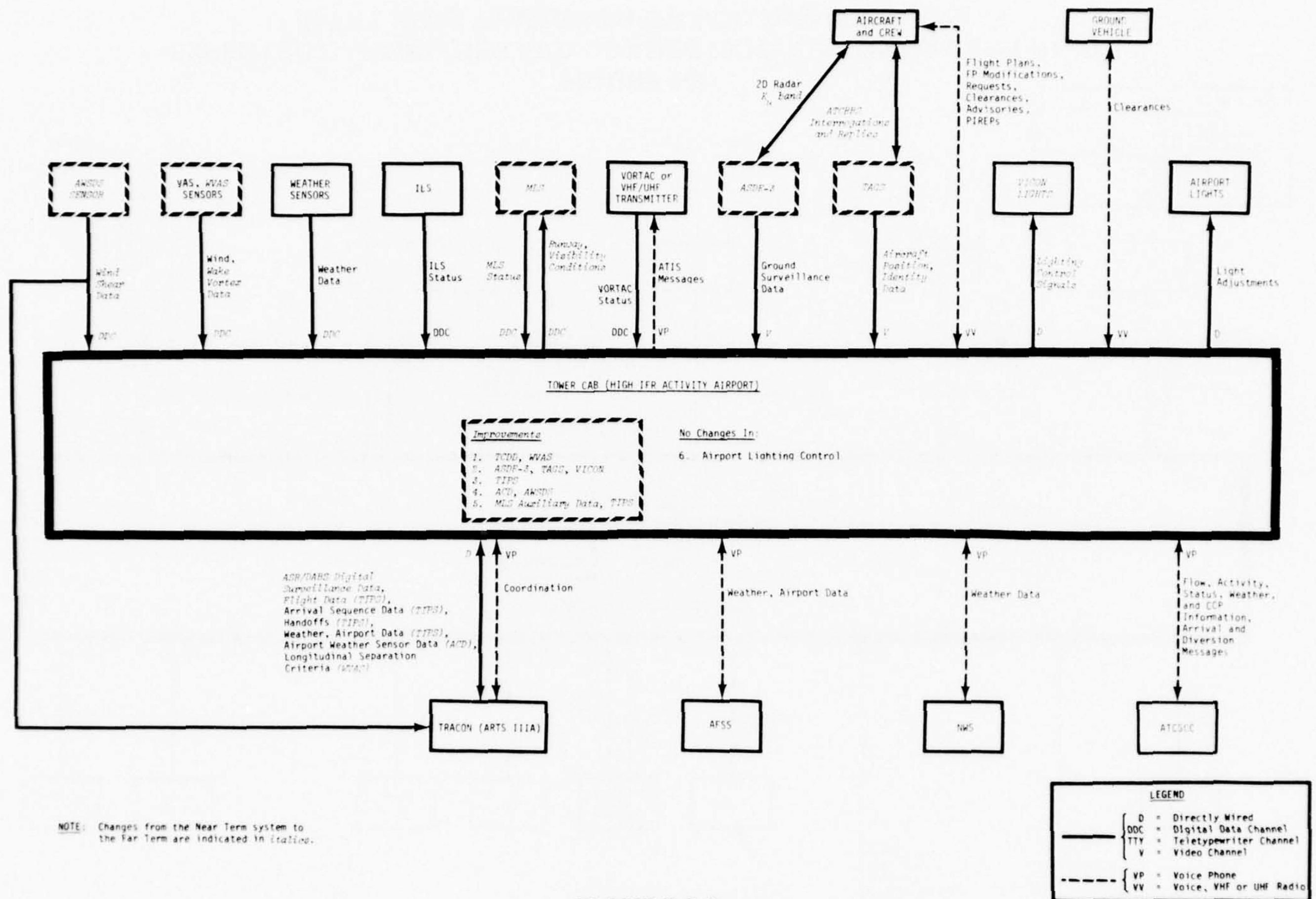


FIGURE 2-8
EXPECTED CAPABILITIES AND CONNECTIVITY OF TOWER FACILITIES IN THE NEAR TERM (HIGH IFR ACTIVITY AIRPORTS)



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

FIGURE 2-9
EXPECTED CAPABILITIES AND CONNECTIVITY OF TOWER FACILITIES IN THE FAR TERM (HIGH IFR ACTIVITY AIRPORTS)

Processing System (TIPS). TIPS would also provide the tower controllers with displays and associated keyboards for fast data entry and retrieval. This would eliminate the need for the outdated Flight Data Entry and Printout (FDEP) equipment and the flight progress strips.

It is anticipated that the VAS system would evolve into the Wake Vortex Avoidance System (WVAS) which is envisioned to have the capability of detecting and predicting the presence and movement of wake vortices along the approach path. Theoretically, this would allow an even greater reduction in separation criteria and further increases in runway throughput. WVAS information would be displayed to controllers in the tower cab and would be forwarded to the TRACON to be used as an input to the Metering and Spacing algorithm.

Another improvement is the replacement of the Low Level Wind Shear Alert System (LLWSAS) with the Advanced Wind Shear Detection System (AWSDS) which would measure wind shear conditions along the approach path in both the horizontal and vertical planes. Data from the AWSDS sensors would be provided to the tower cab via appropriate displays. It is also expected that wind shear data would be forwarded to the ARTS III processor to alert the TRACON controllers to this condition.

Some major changes are anticipated to occur in the ground surveillance area. First, the vacuum tube search radar Airport Surface Detection Equipment (ASDE-2) which is currently in use at some airports would be replaced with solid state ASDE-3 search radars. The ASDE-3 radar will operate at a lower frequency than ASDE-2 and incorporate display improvements that should provide enhanced performance during adverse weather

conditions. Additionally, some high activity airports that currently have no ground surveillance equipment would have the ASDE-3 installed in them. A few of the high activity airports would have the Tower Automated Ground Surveillance (TAGS) System implemented in them to provide the controller with alphanumeric flight identity information in addition to the ASDE-3 search radar information. A study of alternatives for the selection of the best technical approach to achieve the TAGS capability is currently underway.

The numerous displays associated with the status of airport communicatons, navigations and surveillance facilities would be replaced by the Airport Traffic Control Tower Consolidated Display (ACD) which integrates and consolidates this data into one display.* It is also expected that the ACD Processor would conduct some Remote Maintenance and Monitoring functions. Wind shear data, wake vortex data, and weather sensor information (wind, temperature, barometric pressure, etc.) would also be incorporated into the consolidated display.

The existing analog ASR/ATCBI BRITE displays would be replaced by a digital display capability provided at the tower cabs of the major terminal areas. The Tower Cab Digital Display (TCDD) would provide a more reliable and easily maintainable display than today's BRITEs. The TCDD is capable of displaying digitized radar and alphanumeric information.

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*In work related to the System Description effort, the FAA tasked TSC to conduct a study of this subject. The conclusion of that work was that all of the planned improvements could be physically located in existing tower cabs but that a possible integration of certain input/output devices, processors and displays would probably improve the efficiency of operation and reduce overall costs.

Visual Confirmation of Voice Takeoff Clearance (VICON) systems would be installed at most airports equipped with a control tower. VICON consists of a set of signal lights installed at runway departure points, and a control panel in the Tower Cab. The VICON lights are turned on by the controller after takeoff clearance has been delivered. The lights would be turned off automatically after takeoff.

Some of the high VFR activity airports would have Semi-Automated Meteorological Observation Systems (SAMOS) implemented in them. SAMOS would aid the controllers by automatically taking some weather observations and distributing this data to other ATC and NWS facilities. Furthermore, some of the medium VFR activity towers would be provided with Automated Low-Cost Weather Observation Systems (ALWOS). Weather data would be broadcast from these systems to aircraft executing instrument approaches. Wind and altimeter data would also be broadcast to these aircraft by the Wind and Altimeter Voice Equipment (WAVE).

2.3.3 Other Potential Improvements

The FAA is tentatively exploring the utilization of an Automated Terminal Services (ATS) system to provide air traffic control services at VFR airports without a tower cab facility and also at VFR airports with towers that are unmanned during certain shifts when operations are infrequent. The ATC computers are expected to automatically process the surveillance data and issue traffic advisories to arriving and departing aircraft by computer generated voice.

2.4 ATC System Command Center

Major functions currently performed at the ATC System Command Center (ATCSCC) are shown in Figure 2-10. Improvements to the

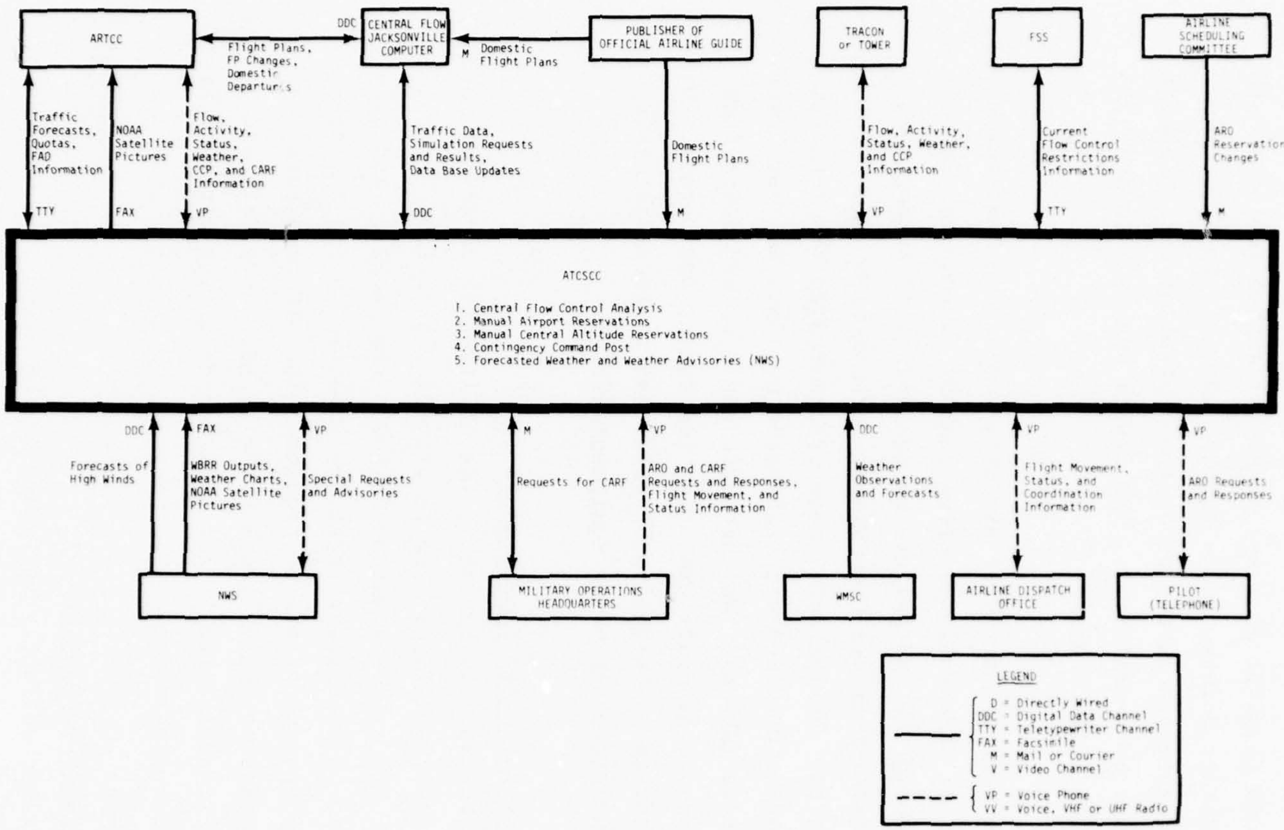


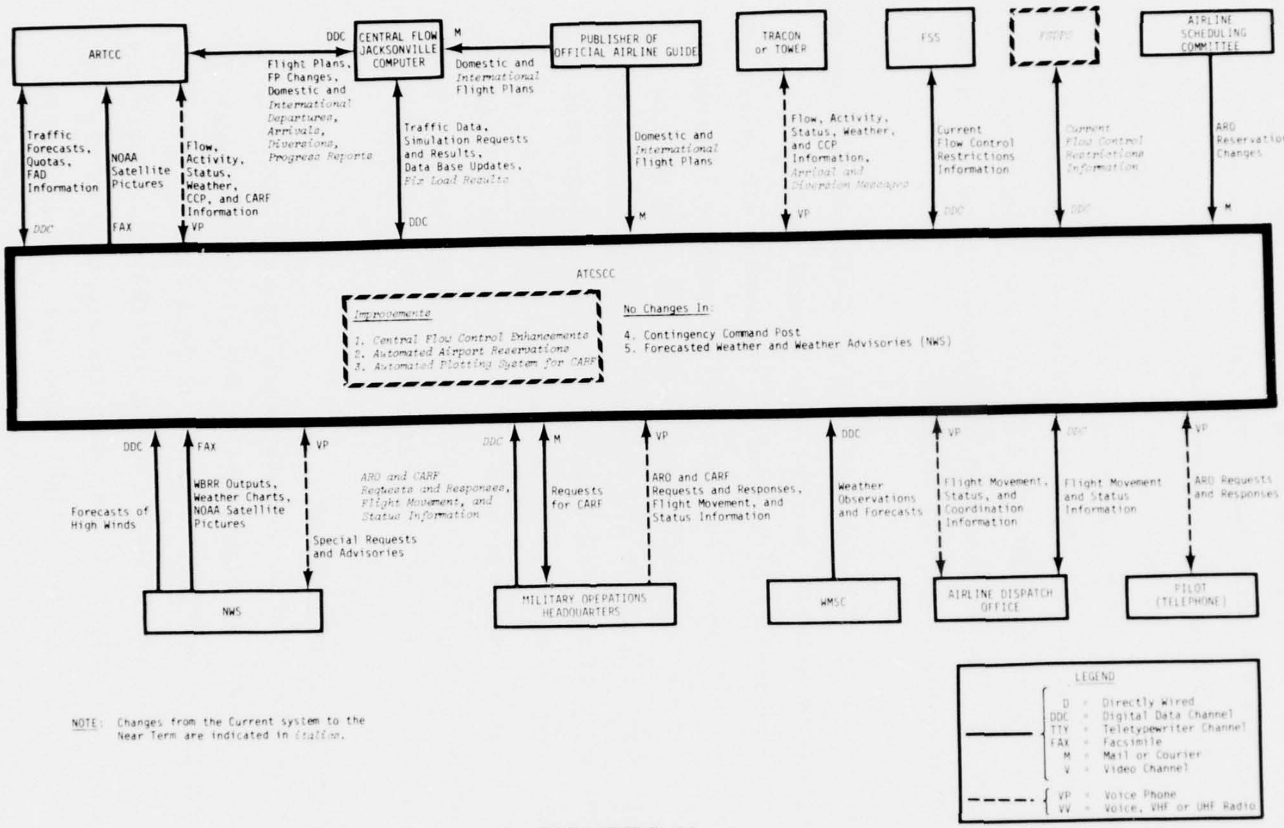
FIGURE 2-10
CAPABILITIES AND CONNECTIVITY OF THE CURRENT ATC SYSTEM COMMAND CENTER

ATCSCC will focus on the Central Flow Control (CFC) function, the Central Altitude Reservations Function (CARF), and the Airport Reservation Office (ARO). The CFC serves as the focal point for evaluating and approving system-wide traffic flow redistributions. The CARF function supports Central Flow Control, and the military, and provides coordination with local flow control specialists at the ARTCCs by providing information on pending military exercises and VIP flights which require air traffic restrictions. The ARO function is intended to relieve congestion at the four highest activity airports.

Ultimately, the operational objective of both Near Term and Far Term improvements in the Central Flow Control function is to enhance the capability of accurately predicting ATC delays and to make available to the en route control centers information that would enhance the management of traffic flow and the equitable distribution of ATC delays. Currently, central flow reacts to major traffic flow crisis situations after they actually happen. While it is impossible to predict all adverse situations, it is the objective of both Near Term and Far Term improvements to improve the accuracy of the predictive capability of central flow, whenever prediction is at all possible.

2.4.1 Near Term Improvements

Major changes expected to be introduced into the ATCSCC in the Near Term are shown in Figure 2-11. One of these changes involves making the Central Flow Control data base more dynamic in that it would reflect more current information. Currently, flight plans for only 15 pacing airports are used by the CFC data base. In the future, flight plans for non-air carrier flights affecting an expanded number of airports serviced by the NAS en route system would be added to the data. Also,



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

FIGURE 2-11
EXPECTED CAPABILITIES AND CONNECTIVITY OF THE ATC SYSTEM COMMAND CENTER IN THE NEAR TERM

currently, aircraft departure information for only 15 pacing airports are sent from the en route computers to the CFC data base. In the Near Term, departure and arrival information for an expanded number of airports and, in addition, departures of international flights heading for a U.S. ARTCC, would be sent to the CFC data base. These improvements in the nature and "currency" of the data are expected to improve the accuracy of the simulations and forecasts.

Another improvement expected in the Near Term is augmentation of the simulation capability to enable obtaining traffic loadings on critical fixes in the national airspace. The current simulation capability is based on data from 15 airports. The expansion of the data base to include more airports would enhance the accuracy of the simulation results.

More airports would participate in the Fuel Advisory Departure (FAD) procedure which is aimed at the conservation of fuel by having aircraft absorb a substantial portion of their expected delays on the ground rather than in the air.

Additionally, in the Near Term, the CARF function will be automated and relocated to Jacksonville. CARF would be provided with an automated plotting system that replaces the current manual system. The ARO function (which has already been relocated to Jacksonville) would be provided with access to the NADIN communications and the CFC data base. This would allow accomplishing reservations, and the associated checking for the availability of a time slot for air carrier and non-air carrier aircraft on a real time basis.

The simulation and data base activities of the ATCSCC are conducted by a dedicated 9020 computer located in Jacksonville.

This computer is the basis of what is termed the CFJC--Central Flow Jacksonville Computer. The communications connectivity between the ATCSCC and the en route control centers is currently accomplished via a combination of relay ARTCCs, store and forward ARTCCs and dedicated high data rate lines. These dedicated lines are expected to be absorbed in the Near Term into the NADIN data communications network.

2.4.2 Far Term and Other Potential Improvements

An expected Far Term improvement is the introduction of correlation between an aircraft airframe identification and Flight ID which would mean that all aircraft would be uniquely identified. Other changes to the Central Flow Control function in the Far Term system have not yet been fully defined. However, one potential change that has been studied by the FAA in the past is centralized flight plan processing. This concept implies that some central facility would have knowledge in its data base of all flight plans, current and future. Such a data base could be used in determining (with sufficient lead time) the expected loadings on various sectors of the airspace.

2.5 Flight Service Facilities

Currently the great majority of the services provided by Flight Service Facilities are conducted manually. Some of the major functions currently performed at these facilities are illustrated in Figure 2-12 along with the connectivity to other facilities.

2.5.1 Near Term Improvements

Some of the major changes expected to occur in Flight Service Facilities in the Near Term are highlighted in Figure 2-13. An expected improvement is the availability of Flight Service

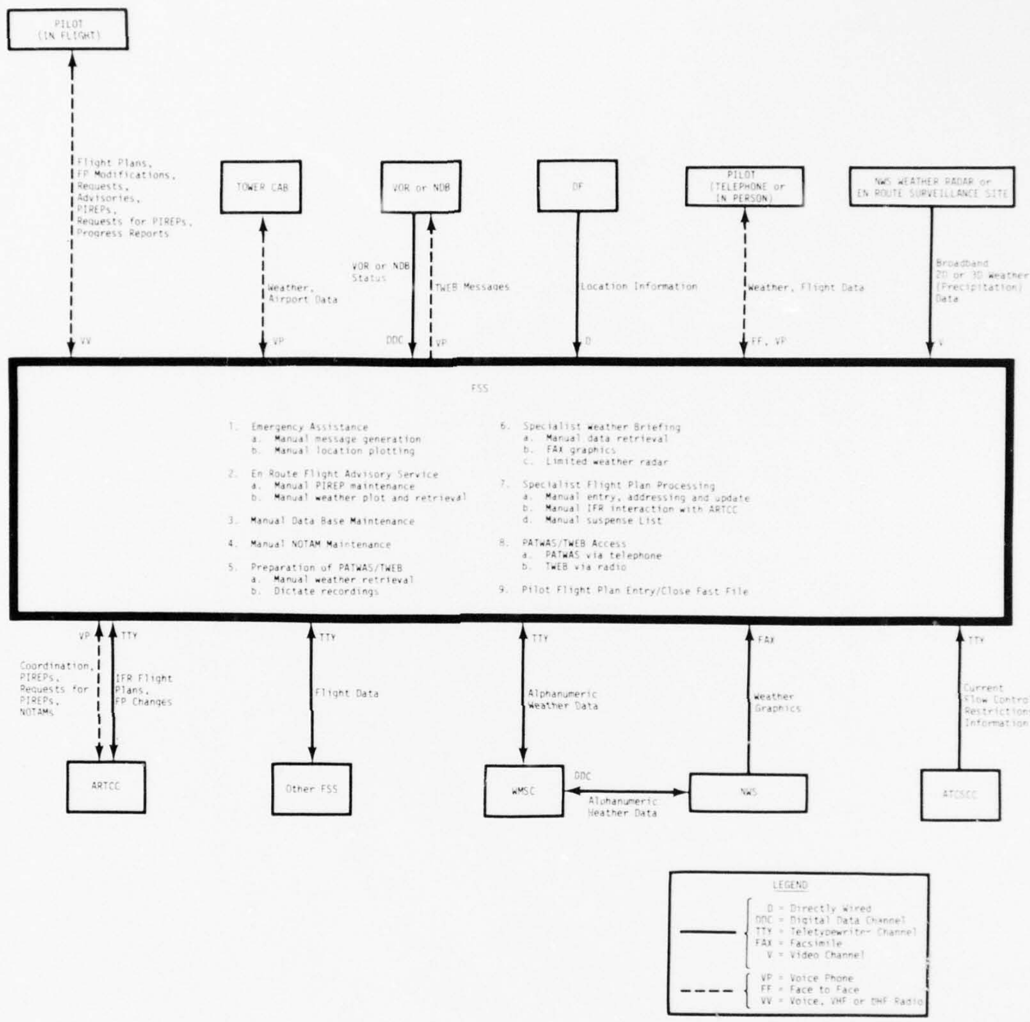
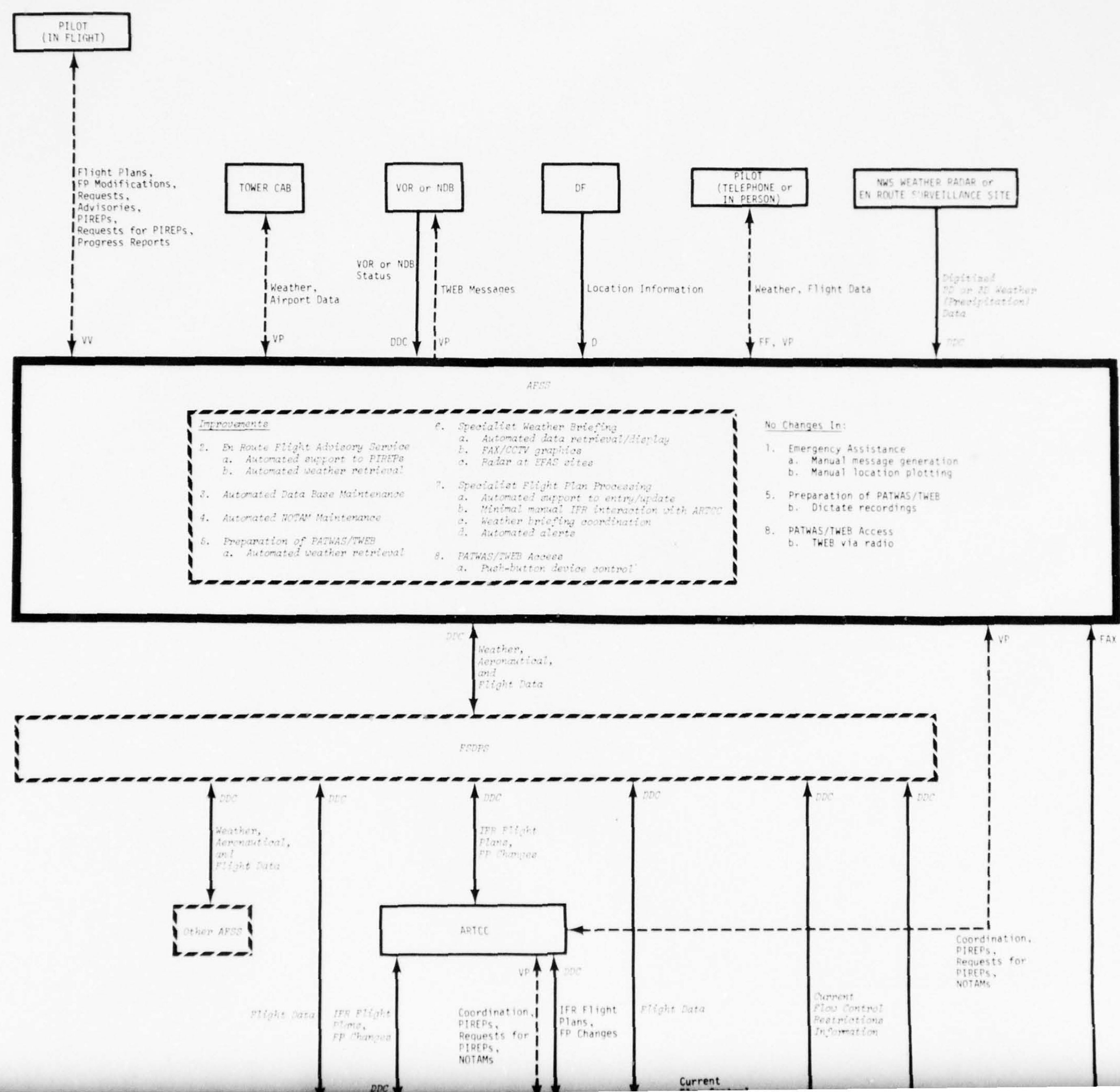


FIGURE 2-12
CAPABILITIES AND CONNECTIVITY OF CURRENT FLIGHT SERVICE FACILITIES



PILOT (IN FLIGHT)
Flight Plans, FP Modifications, Requests, Advisories, PIREPs, Requests for PIREPs, Progress Reports
VV
TOWER CAB
Weather, Airport Data
VP
VOR or NDB
VOR or NDB Status
DDC
TWEB Messages
VP
DF
Location Information
D
PILOT (TELEPHONE or IN PERSON)
Weather, Flight Data
FF, VP
NWS WEATHER RADAR or EN ROUTE SURVEILLANCE SITE
Digitized 2D or 3D Weather (Precipitation) Data
DDC
AFSS
Improvements
2. En Route Flight Advisory Service
a. Automated support to PIREPs
b. Automated weather retrieval
3. Automated Data Base Maintenance
4. Automated NOTAM Maintenance
5. Preparation of PATWAS/TWEB
a. Automated weather retrieval
6. Specialist Weather Briefing
a. Automated data retrieval/display
b. FAX/CCTV graphics
c. Radar at EFAS sites
7. Specialist Flight Plan Processing
a. Automated support to entry/update
b. Minimal manual IFR interaction with ARTCC
c. Weather briefing coordination
d. Automated alerts
8. PATWAS/TWEB Access
a. Push-button device control
No Changes In:
1. Emergency Assistance
a. Manual message generation
b. Manual location plotting
5. Preparation of PATWAS/TWEB
b. Dictate recordings
8. PATWAS/TWEB Access
b. TWEB via radio
DDC
Weather, Aeronautical, and Flight Data
VP
FAX
FSDPS
DDC
Weather, Aeronautical, and Flight Data
Other AFSS
DDC
IFR Flight Plans, FP Changes
ARTCC
Coordination, PIREPs, Requests for PIREPs, NOTAMs
VP
DDC
Flight Data
IFR Flight Plans, FP Changes
Coordination, PIREPs, Requests for PIREPs, NOTAMs
IFR Flight Plans, FP Changes
Flight Data
Current Flow Control Restrictions Information
Current

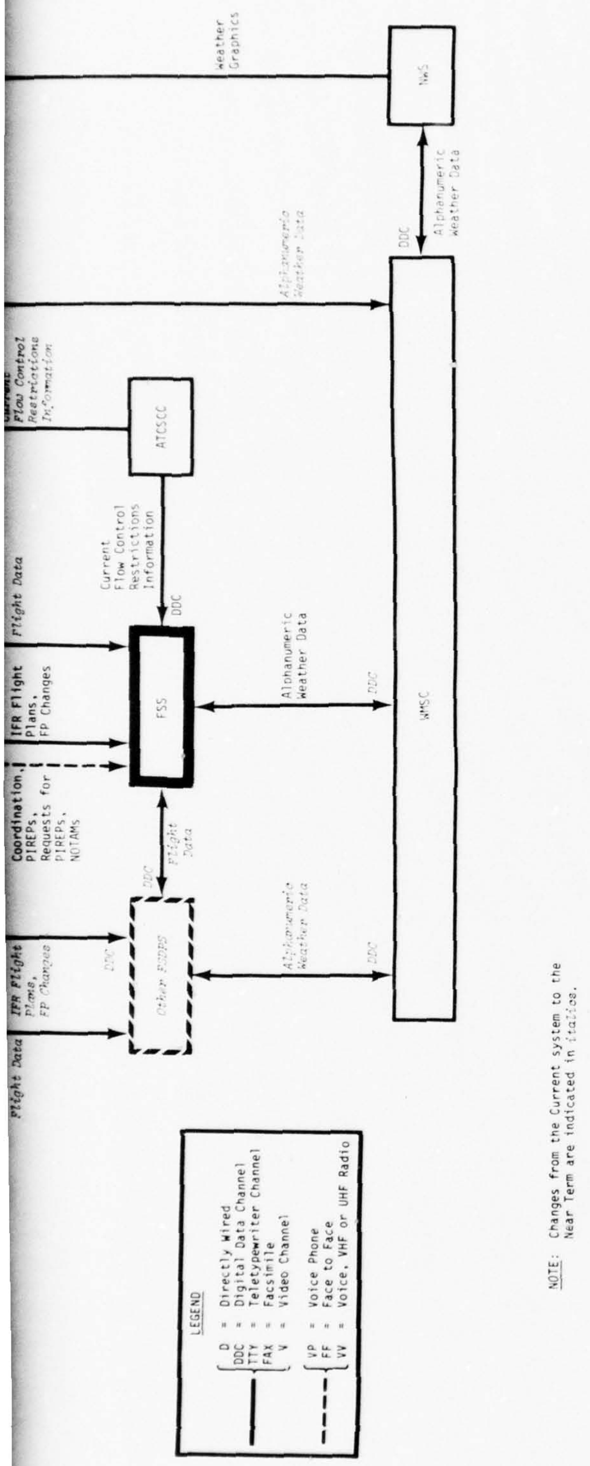


FIGURE 2-13
EXPECTED CAPABILITIES AND CONNECTIVITY OF FLIGHT SERVICE FACILITIES IN THE NEAR TERM

Data Processing Systems (FSDPS) which will be colocated with the ARTCCs, and would provide centralized computer support to some flight service facilities. Other facilities would continue their manual mode of operation. Those facilities that would have automation support are referred to as Automated Flight Service Stations (AFSS).

The automation aids available to the flight service specialist include the automated monitoring of lists of inbound aircraft and the generation of an alert to the specialist when an aircraft is overdue. The specialist at the destination AFSS would continue to manually initiate the Search and Rescue (SAR) alert and information requests. The retrieval of data on the overdue aircraft would be done automatically at the departure or en route AFSS, but the data must be manually addressed to the requesting AFSS.

Automation support would be provided for the input, maintenance and retrieval of Pilot Reports (PIREPs) which provide the basis of weather plots manually maintained by the AFSS specialists that handle the En Route Flight Advisory Service (EFAS). PIREPs would be entered by the specialist at the AFSS and would be forwarded to the FSDPS which would in turn forward it to the Weather Message Switching Center (WMSC). PIREPs from other sources would also be sent to the WMSC where a national PIREP data base would be maintained and distributed to the FSDPSs, for use by the automated flight service facilities.

Automated support would also be provided to the flight service specialists in the retrieval of weather and aeronautical conditions information. The retrieval of this information from the data base could be by predefined sequences of locations and

weather message type or can be by geographical area or given routes of flight. Graphics from the NWS are made available more conveniently using closed circuit television. Digital weather radar would be available at the 44 EFAS positions.

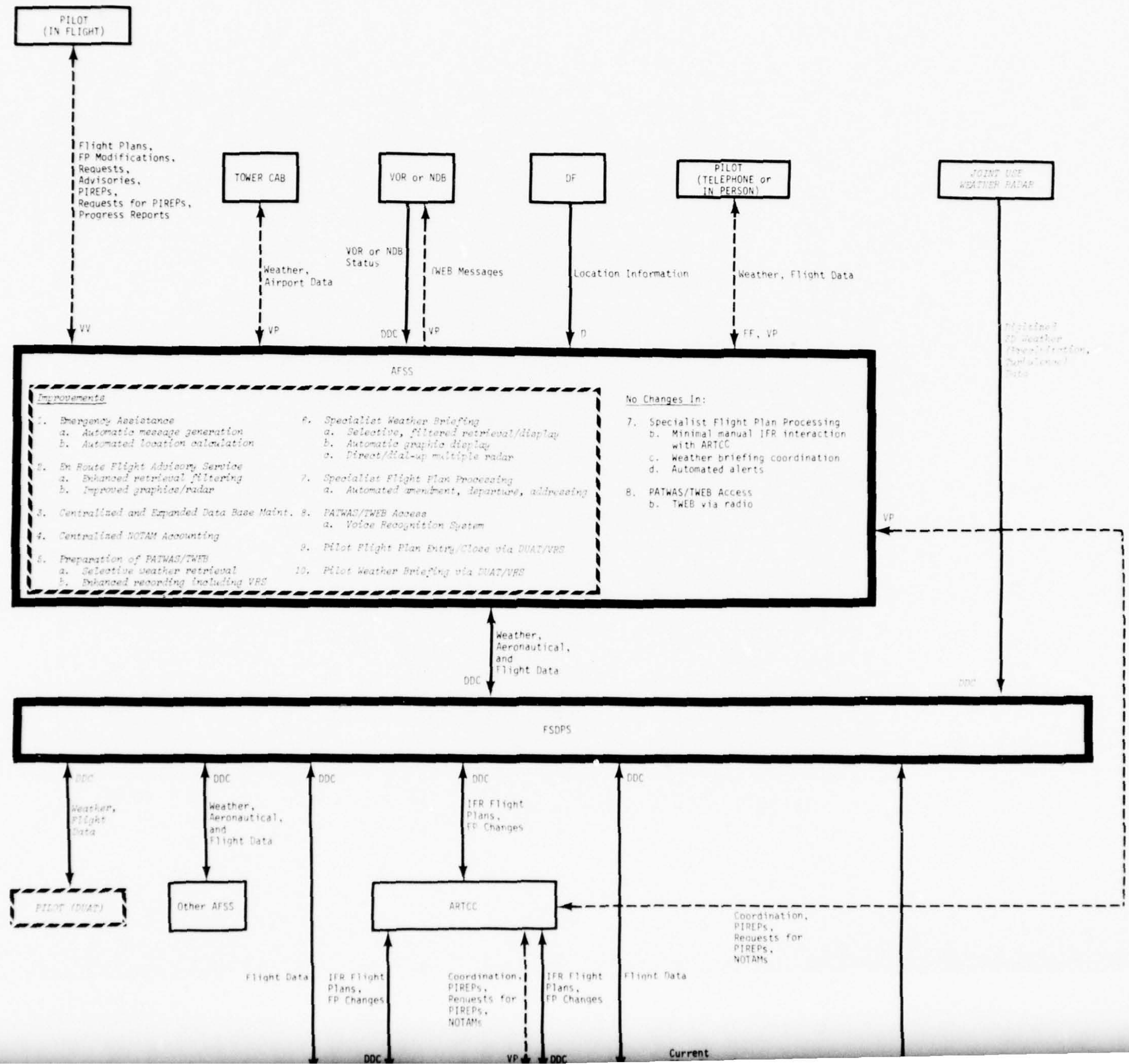
Automated support in formating and error checking of flight plans entered by the specialist would also be provided by the FSDPS. Flight plan filing by the specialist would be simplified in that flight plan information entered for the purpose of a weather briefing would be retained and used for filing instead of having to be reentered.

The specialist would continue to manually monitor the Navigational Aids (NAVAIDS) that are associated with the flight service facility, but automated support for the entry, distribution and retrieval of Notices to Airmen (NOTAM) information would be provided to the specialist. NOTAMs would be entered into the FSDPS data base in accordance with formats provided by the computer. The FSDPS would transmit the NOTAMs to the WMSC for nationwide distribution.

Instead of the current manual search for information to be used in preparing recordings for the Pilot Automatic Telephone Weather Answering Service (PATWAS) and the Transcribed Weather Broadcast (TWEB) functions, the AFSS specialist would use the extensive and flexible data accessing capability to obtain the appropriate text required for the broadcast. The text would include canned statements as well as the dynamic weather and aeronautical messages required for that specific broadcast. The retrieved information would be presented to the specialist on a display device for editing. The specialist would then record the reports as in the current system. Pilot access to PATWAS may be accomplished using push button control.

2.5.2 Far Term Improvements

In this report, the assumption was made that in the Far Term there will be no consolidation of flight services into twenty hub locations. A decision, however, on whether or not to consolidate is expected to be made by 1983. In this report, both manual and automated flight service facilities were assumed to continue to exist during the post-1983 time period. Regardless of the consolidation decision, it is expected that the improvements that are indicated in Figure 2-14 would occur. One of these improvements is the availability of an expanded weather data base from the Aviation Weather Processor (AWP). The AWP would provide data base maintenance for weather and aeronautical information including editing and reformating capabilities for the data distributed to the FSDPSs to be utilized in support of both specialists and pilots. Other improvements include the availability of Direct User Access Terminals (DUAT) to be used by pilots in interactively accessing the data base and in filing flight plans. Some DUAT terminals would have the added capability of displaying graphics to pilots as part of the self briefing. Pilots can retrieve weather and aeronautical information by routes or by specific location. The pilot may also request weather information by push button telephone entry and receive it by computer generated voice utilizing the Voice Response System (VRS). Flight plans entered by push button telephones would be echoed back to the pilot by the VRS system for confirmation or correction. (Although the VRS system is expected to be implemented in the Far Term, certain elements of it might be implemented in the Near Term, depending on the outcome of ongoing studies.) IFR flight data entered by the pilot into the system would be transmitted automatically to the departure ARTCC. VFR flight data would be transmitted automatically (upon aircraft departure) to the departure and the destination AFSSs.


PILOT (IN FLIGHT)
Flight Plans, FP Modifications, Requests, Advisories, PIREPs, Requests for PIREPs, Progress Reports
VV
TOWER CAB
Weather, Airport Data
VP
VOR or NDB
VOR or NDB Status
DDC
TWEB Messages
VP
DF
Location Information
D
PILOT (TELEPHONE or IN PERSON)
Weather, Flight Data
FF, VP
JOINT USE WEATHER RADAR
AFSS
Improvements
1. Emergency Assistance
a. Automatic message generation
b. Automated location calculation
2. En Route Flight Advisory Service
a. Enhanced retrieval filtering
b. Improved graphics/radar
3. Centralized and Expanded Data Base Maint.
4. Centralized NOTAM Accounting
5. Preparation of PATWAS/TWEB
a. Selective weather retrieval
b. Enhanced recording including VRS
6. Specialist Weather Briefing
a. Selective, filtered retrieval/display
b. Automatic graphic display
c. Direct/dial-up multiple radar
7. Specialist Flight Plan Processing
a. Automated amendment, departure, addressing
8. PATWAS/TWEB Access
a. Voice Recognition System
9. Pilot Flight Plan Entry/Close via DUAT/VRS
10. Pilot Weather Briefing via DUAT/VRS
No Changes In:
7. Specialist Flight Plan Processing
b. Minimal manual IFR interaction with ARTCC
c. Weather briefing coordination
d. Automated alerts
8. PATWAS/TWEB Access
b. TWEB via radio
VP
Weather, Aeronautical, and Flight Data
DDC
FSDPS
DDC
Weather, Flight Data
PILOT (DUAT)
DDC
Weather, Aeronautical, and Flight Data
Other AFSS
DDC
DDC
IFR Flight Plans, FP Changes
ARTCC
DDC
Coordination, PIREPs, Requests for PIREPs, NOTAMs
Flight Data
IFR Flight Plans, FP Changes
Coordination, PIREPs, Requests for PIREPs, NOTAMs
IFR Flight Plans, FP Changes
Flight Data
DDC
VP
DDC
Current

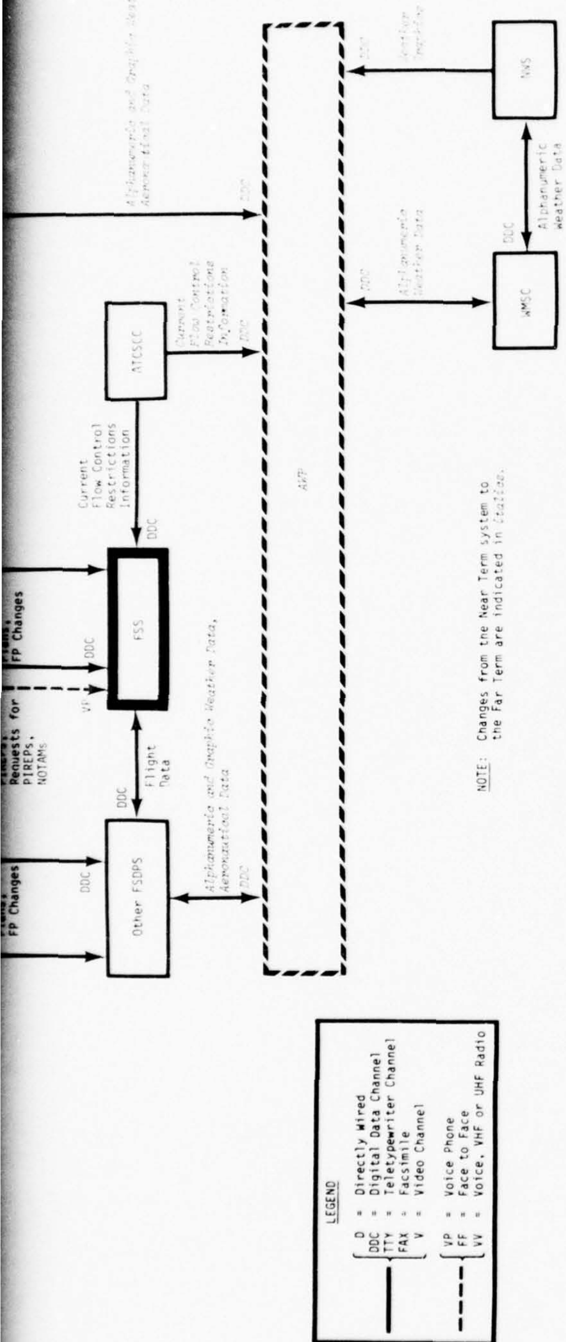


FIGURE 2-14
EXPECTED CAPABILITIES AND CONNECTIVITY OF FLIGHT SERVICE FACILITIES IN THE FAR TERM

Retrieval of weather briefing information by specialists is expected to be made more selective and flexible; route oriented briefings may utilize preferred routes; reports could be filtered on the basis of weather activity. Thus, the specialist would be provided only the data that is pertinent to the route of flight. Graphic weather charts and weather radar data would reside in the FSDPS and in local storage at the AFSS. The graphic data would be displayed on dedicated video terminals. Automation support in the transmittal of flight plans would also be made available to the specialists.

Far Term improvements in Search and Rescue (SAR) and aid to lost aircraft are also expected. In addition to automated alerts, a SAR message would be automatically generated and displayed to the destination AFSS specialist prior to transmittal to the appropriate en route and departure facilities. The automation system (FSDPS) would provide automatic message addressing. Upon receipt of the SAR message at en route and/or departure AFSSs, the requested information would then be automatically generated and displayed at a specialist position prior to transmittal back to the requesting facility.

To provide position location to lost or disoriented pilots, specialists would manually input aircraft bearing information (obtained from navigation aids or direction finder sites) into the FSDPS. The FSDPS would then compute and display the location and the aircraft heading to a specified location.

The En Route Flight Advisory Service (EFAS) specialist who handles the PIREPs would be provided a flexible weather and graphics retrieval capability. For example, the specialist may retrieve PIREPs for a corridor along a route or for a given

distance from some location. PATWAS and TWEB recordings would be simplified in that the weather report for a location would be recorded once and the system would insert the report in the files under all the appropriate routes which contain that location. Reports would also be automatically entered into the PATWAS/ TWEB recordings by the Voice Response System (VRS). Access to PATWAS may be done utilizing push button control or via a limited voice recognition capability.

2.5.3 Other Potential Improvements

Potential system improvements that are being considered by the National Weather Service focus on improving the prediction and dissemination of weather information. These include the development of a nationwide "grid" weather data base and the inclusion of more current upper air wind/temperature in that data base. This data base would have weather information at points of a two-dimensional grid equally distributed and covering the whole United States. The information at these points would include weather at various altitudes.

A potential improvement being considered by the FAA is the eventual combining of the Aviation Weather Processor (AWP) and the Weather Message Switching Center (WMSC).

2.6 Surveillance Facilities

2.6.1 En Route Surveillance Facilities

Figure 2-15 highlights the capabilities and connectivity of Current En Route Surveillance facilities. The Current capabilities consist of a Search Radar, a Beacon Interrogator, and Surveillance Data Preprocessor.

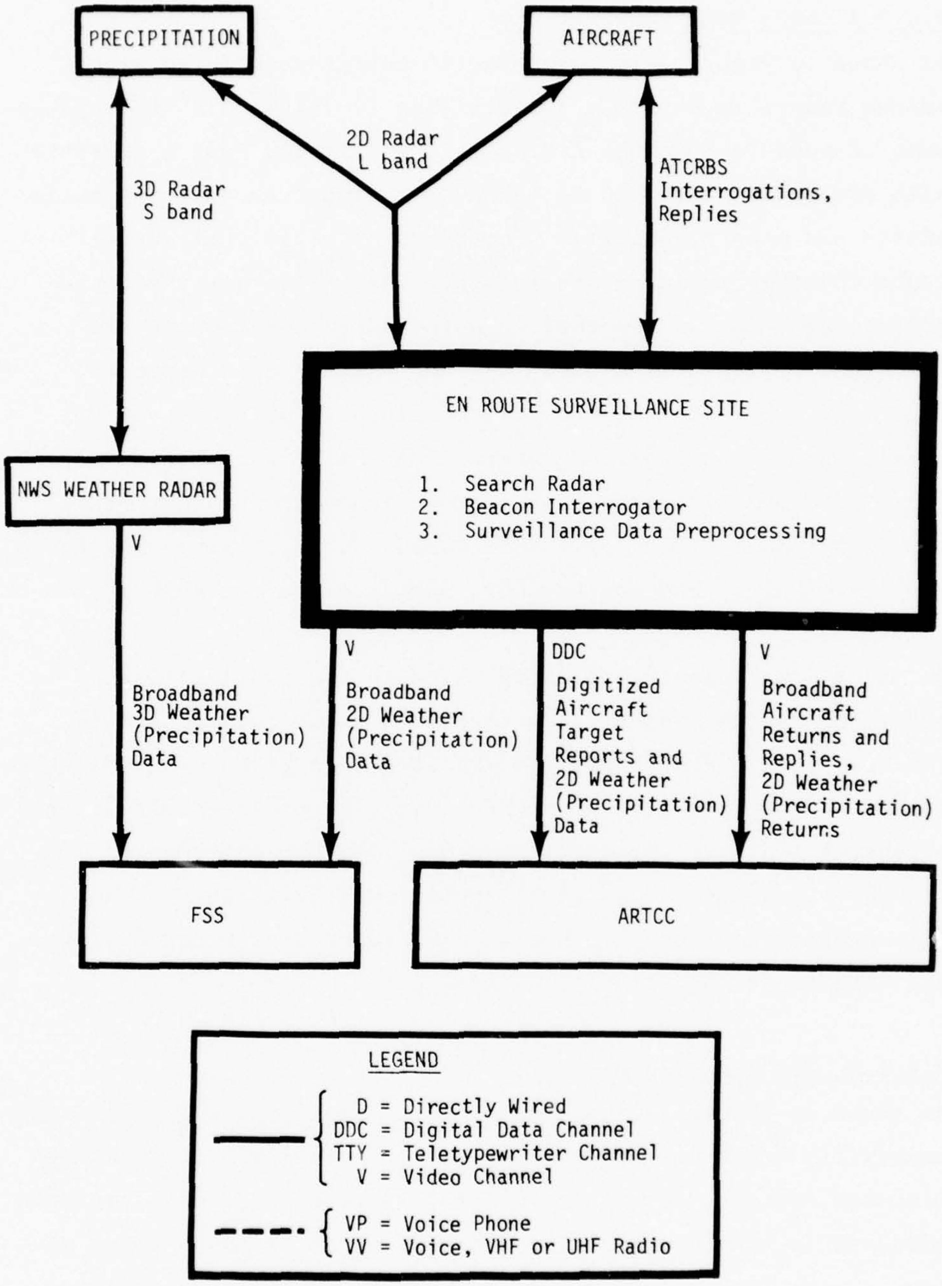


FIGURE 2-15
CAPABILITIES AND CONNECTIVITY OF CURRENT EN ROUTE SURVEILLANCE FACILITIES

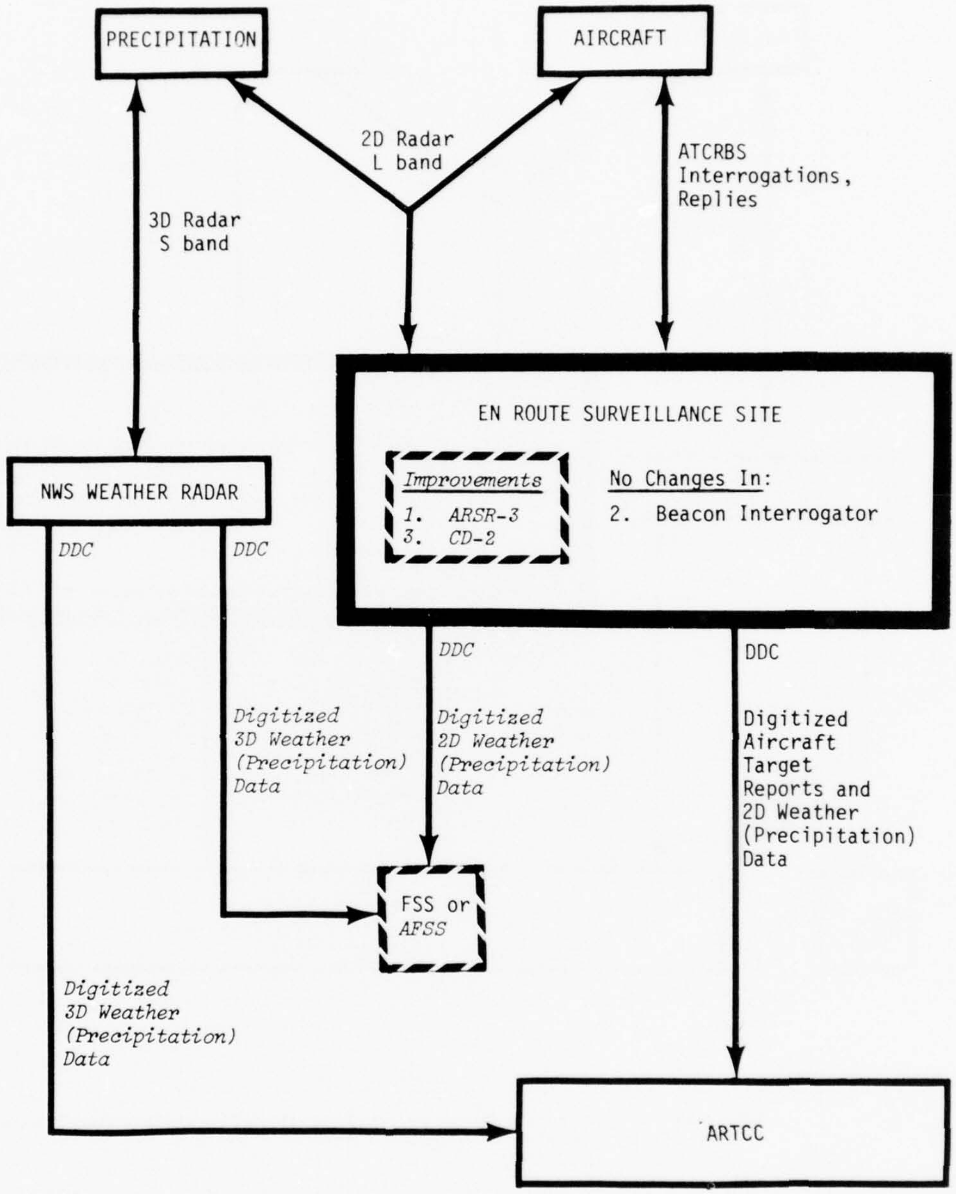
2.6.1.1 Near Term Improvements

As shown in Figure 2-16, an expected change associated with search radars in en route surveillance facilities is the replacement of some vacuum tube Air Route Surveillance Radars (ARSR-1) with new solid state radars (ARSR-3) to improve equipment reliability and maintainability. Furthermore, additional surveillance coverage would be attained by wider deployment of these solid state radars. Another expected improvement is the replacement of the Common Digitizer (CD) with a dual Common Digitizer (CD-2) to enhance system reliability, and to aid in attaining a 24 hour/day operational capability. Furthermore, the CD-2 would have circuitry that replaces the Weather Fixed Map Unit (WFMU) circuitry. This would result in improving the quality of digitized weather data forwarded to the ARTCC.

No major improvements are anticipated in the availability of hazardous weather information to the en route controllers in the Near Term. However, it is expected that at some ARTCCs, the Center Weather Service Unit (CWSU) would be provided with three dimensional (range, azimuth, altitude) weather information provided by the National Weather Service (WSR-57) radars. The interpretation of the weather data would be disseminated from the CWSU to the air traffic controllers.

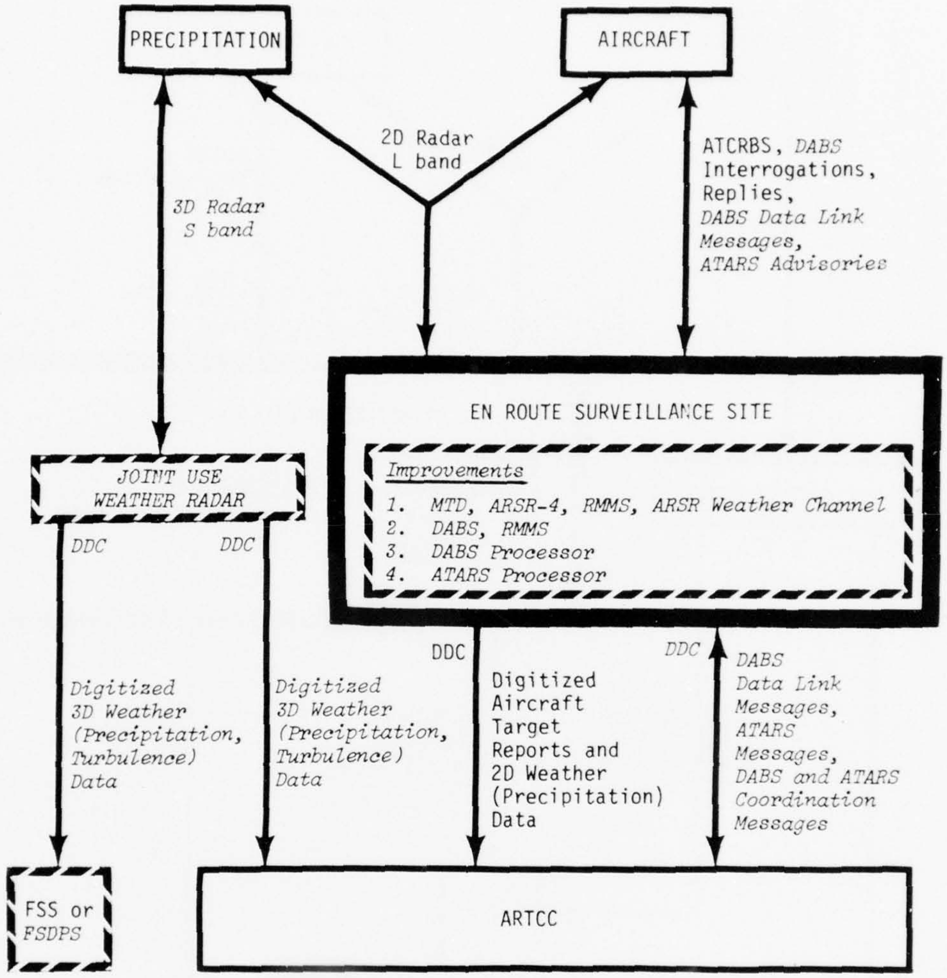
2.6.1.2 Far Term Improvements

As shown in Figure 2-17, it is expected that discrete addressing capability would be made available by the implementation of the Discrete Address Beacon System (DABS). With DABS, each equipped aircraft is assigned a unique address, which is transmitted as part of the beacon interrogation message. This is an improvement over the current ATCRBS system where all aircraft within the beam of the beacon antenna would respond to the interrogation.



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

FIGURE 2-16
EXPECTED CAPABILITIES AND CONNECTIVITY OF EN ROUTE SURVEILLANCE FACILITIES IN THE NEAR TERM



NOTES

1. Both weather improvements (i.e., the Joint Use Weather Radar and the ARSR Weather Channel) are shown.

2. Changes from the Near Term system to the Far Term are indicated in *italics*.

FIGURE 2-17
EXPECTED CAPABILITIES AND CONNECTIVITY OF EN ROUTE SURVEILLANCE FACILITIES IN THE FAR TERM

The DABS unique addressing capability decreases the possibility of garbling due to simultaneous beacon replies.

Since it is expected that both the DABS and ATCRBS environments would co-exist for sometime, the DABS equipment would be designed to be compatible with the existing ATCRBS equipment. Thus, the DABS interrogators would be capable of interrogating both DABS and ATCRBS equipped aircraft. Similarly, DABS transponders would be capable of responding to ATCRBS interrogators.

Another improvement is the introduction of the Automated Traffic Advisory and Resolution Service (ATARS) at each of the DABS surveillance sites. Messages to resolve a conflict would be automatically generated based on DABS surveillance information and would be communicated to the pilot via the DABS Data Link. Conceptually, ATARS messages would be communicated to the pilot after Conflict Alert has been issued and yet the threat of collision continues to persist. ATARS messages would be sent to the appropriate controller to apprise him of the intentions of the involved aircraft. Terrain avoidance and avoidance of obstacles and restricted airspace are possible future additions to the ATARS capability. In addition to its use for the transmission of the ATARS messages, the DABS Data Link would be available for the automatic transmission of ATC messages or other advisories.

Search radar equipment reliability would be improved by the continued implementation of solid state radars to replace the remaining older tube type radars. Thus, in the Far Term the ARSR-4 would be implemented. This radar would have an improved aircraft detection capability and a separate weather channel to improve weather detection.

The use of the same channel for both weather and aircraft targets as is currently done has been recognized to be less than optimum for the detection of weather. In the Far Term, a separate ARSR weather channel may be used in the ARSR-3 and ARSR-4 radars to provide processing to optimize the detection of weather. This weather channel may actually be one of two redundant channels or it may be a new channel which would be implemented if it was found desirable to maintain the same level of redundancy.

A further improvement in this era is the implementation of the Moving Target Detector (MTD) within the search radar target detection circuitry to replace the older Moving Target Indicator (MTI) circuitry. The use of MTD would result in improving aircraft detection when the aircraft is moving at or near zero radial velocity and in an environment of heavy clutter. Heavy clutter may be due to weather or due to ground targets.

Another improvement in the Far Term is the expected introduction of the Joint Use Weather Radar network for use by the FAA, National Weather Service (NWS), and Air Weather Service (AWS). These radars would utilize pencil beam antennas to obtain three-dimensional weather information and would also utilize doppler frequency processing to automatically detect weather turbulence and forecast its movements ten to twenty minutes in advance.

Finally, improved surveillance system availability and maximum utilization of personnel would be attained by the introduction of the Remote Maintenance Monitoring System (RMMS), which also encompasses navigation facilities and ARTCC air-ground communications sites. According to current RMMS planning, key status parameters from the search and beacon radars and from the common

digitizer would be remoted to the ARTCC, for monitoring, certification and trend analysis.

2.6.2 Terminal Surveillance Facilities

Figure 2-18 highlights the capabilities and connectivity of terminal surveillance facilities. The same capabilities that are provided by the surveillance facilities in the Current system would continue to be provided in the Near Term system as well. Thus, there are no major improvements expected in the Near Term in terminal surveillance facilities.

2.6.2.1 Far Term Improvements

As shown in Figure 2-19, it is expected that surveillance in the ARTS IIIA terminal area would be enhanced with the introduction of discrete addressing by implementing the DABS capability. Currently, without discrete addressing, simultaneous replies by aircraft ATCRBS transponders could result in garbling of the information. With DABS, garbling would be reduced. The DABS equipment would be compatible with ATCRBS equipment, both on the ground and in the aircraft. Another improvement is the introduction of ATARS at each DABS surveillance site at the ARTS III facilities. DABS surveillance information would be used by the ATARS processor to resolve a conflict and messages would be automatically generated and communicated to the pilot via the DABS Data Link. This service is provided by ATARS if a conflict continued to persist after other warnings from terminal Conflict Alert have been issued. ATARS messages would be sent to the controller in charge of the airspace of the involved aircraft in order to keep him advised of the intentions of those aircraft. ATARS may be augmented to include an advisory service for terrain avoidance and avoidance of obstacles or restricted air traffic control areas. As in the

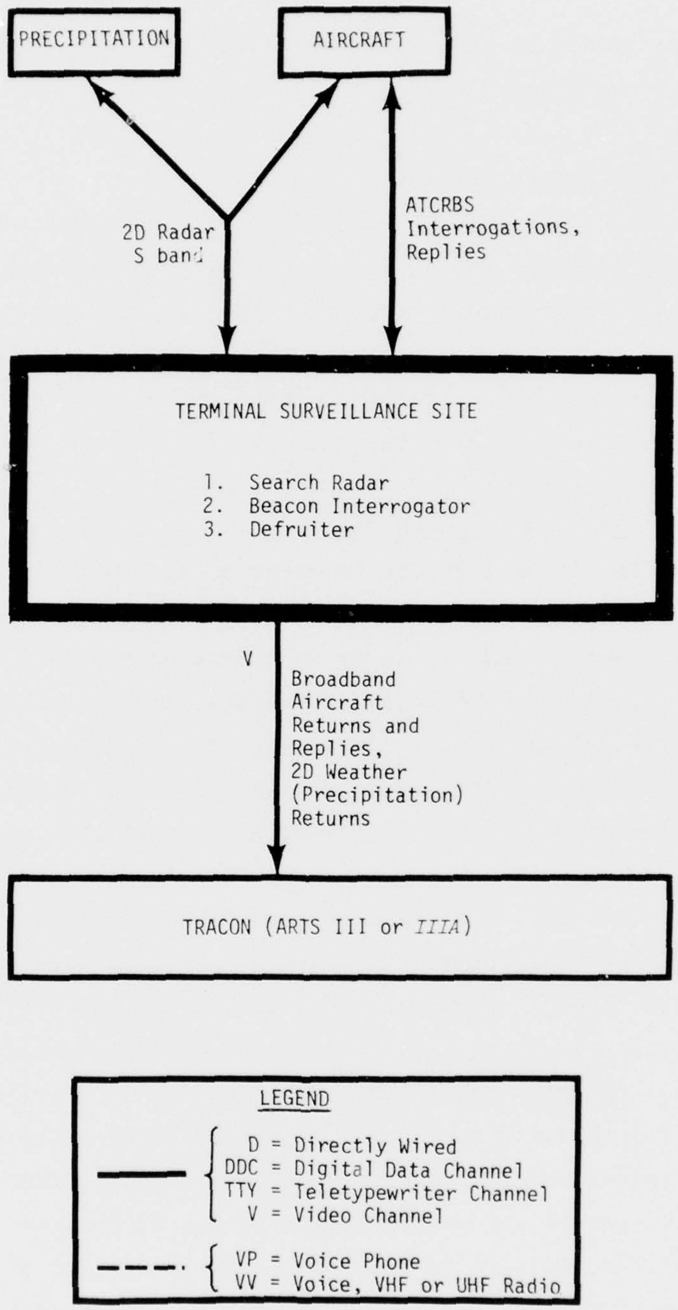
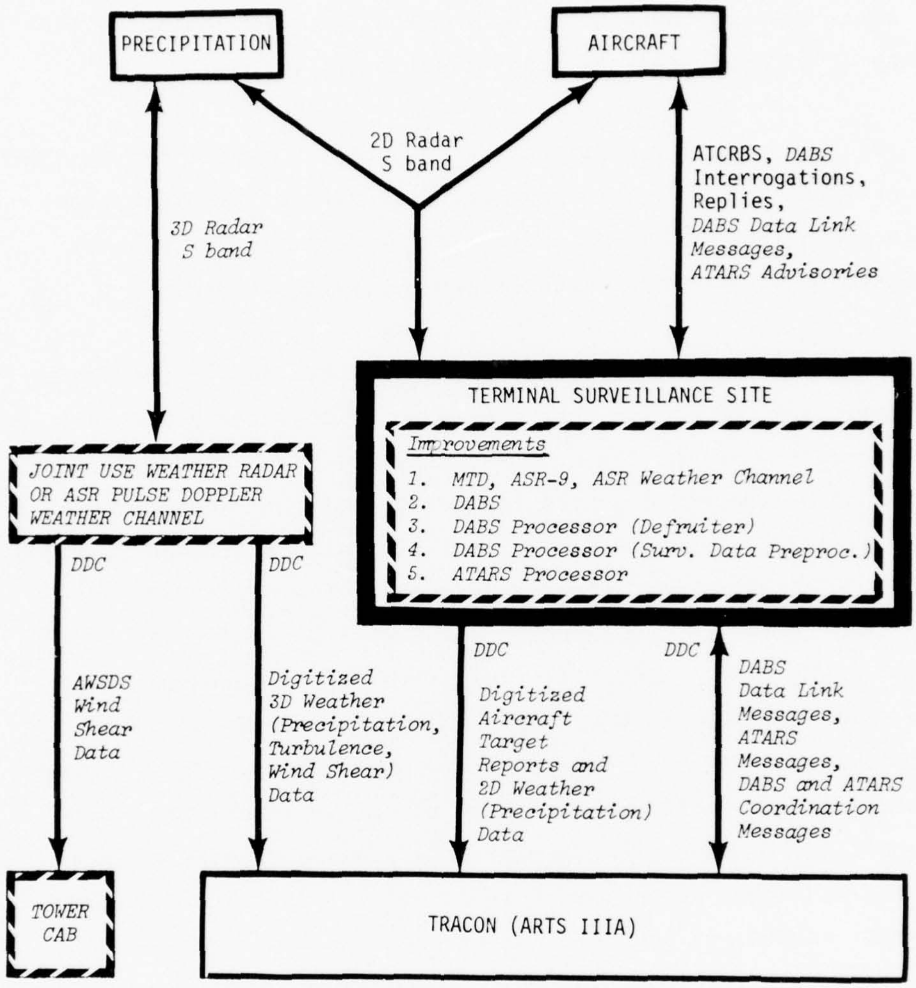


FIGURE 2-18
CAPABILITIES AND CONNECTIVITY OF CURRENT AND NEAR TERM TERMINAL SURVEILLANCE FACILITIES



NOTES

1. Both weather improvements (i.e., the ASR Weather Channel and the Joint Use Weather Radar or ASR Pulse Doppler Weather Channel) are shown.

2. Changes from the Near Term system to the Far Term are indicated in *italics*.

FIGURE 2-19
EXPECTED CAPABILITIES AND CONNECTIVITY OF TERMINAL SURVEILLANCE FACILITIES IN THE FAR TERM

en route system, the DABS Data Link would be available for the relay of ATC messages and advisories to the pilot.

As in the en route facilities, the use of a separate ASR weather channel is expected to improve the detection of precipitation. This channel would be optimized for the detection of weather against a background of clutter and aircraft targets.

Improvement in aircraft detection is expected due to the implementation of the Moving Target Detector (MTD) to replace the MTI circuitry in the detection of targets in the search radars. It is also expected that the replacement of the vacuum tube ASR-4s, ASR-5s, and ASR-6s with the new solid state ASR-9s would occur in the Far Term. Implementation of the new ASR-9 is expected to take place throughout the entire terminal ATC system and not only at ARTS III facilities. It is expected that the Joint Use Weather Radar surveillance information would be made available at some major terminal facilities. These radars would utilize pencil beam antennas to obtain three-dimensional weather information with doppler frequency processing to automatically detect weather turbulence and forecast its movements several minutes in advance. Other major terminal areas that do not have coverage by the Joint Use Weather Radars would obtain turbulent weather information through the use of pulse doppler techniques that would be implemented as a modification to the terminal radars. It is also expected that wind shear data would be provided to the tower cab and to the TRACONS of the terminal areas that have coverage by the sophisticated radars.

2.6.2.2 Other Potential Improvements

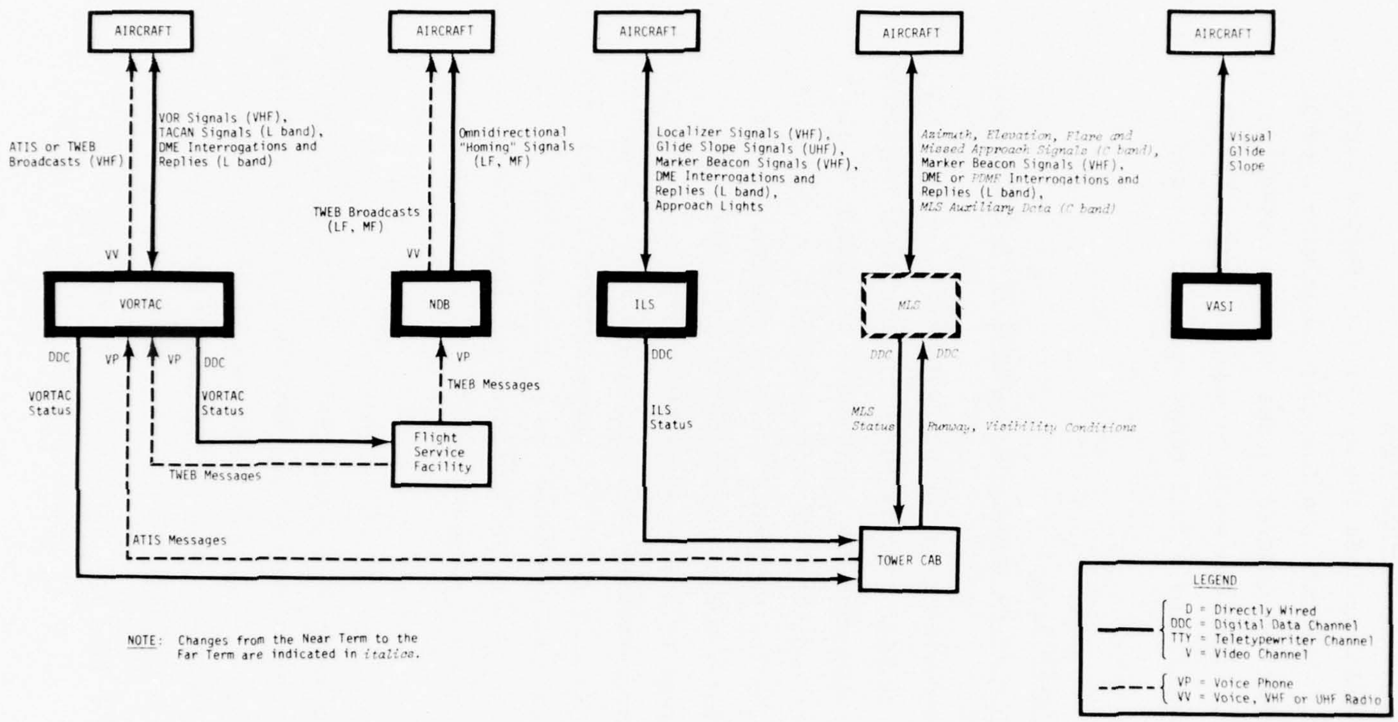
Potential improvements include the use of the Limited Surveillance Radar (LSR). The LSR is a low cost radar with a range of 20 nautical miles as compared to the 60 miles detection range of the ASRs. The LSRs would be used at some airports that could not qualify for a full radar approach control service.

2.7 Navigation Facilities

2.7.1 Improvements in En Route and Terminal Area Navigation Facilities

An anticipated improvement in the navigation facilities (see Figure 2-20) in the Near Term is the replacement of old vacuum tube VORs and VORTACs with new solid state equipment in order to increase the reliability and maintainability of the navigation equipment. In the Far Term, a remote maintenance and monitoring capability would be applied to the navigation facilities, in order to reduce maintenance costs and to improve availability. Key parameter information would be remoted to the central processor at the ARTCC where records are kept and trend analyses would be performed, as part of an overall program (RMMS) that handles RCAGs and en route surveillance sites as well. Remote certification would also be made possible by RMMS.

A potential improvement in the navigation facilities is the use of Satellite navigation such as the NAVSTAR Global Positioning System (GPS), which may be considered when feasibility and desirability are proven. Another potential improvement is the utilization of time navigation (RNAV with time as a parameter) as a backup to a fully automated ATC system.



NOTE: Changes from the Near Term to the Far Term are indicated in *italics*.

FIGURE 2-20
CAPABILITIES AND CONNECTIVITY OF NAVIGATION AND LANDING FACILITIES

2.7.2 Improvements in Approach and Landing Navigation Facilities

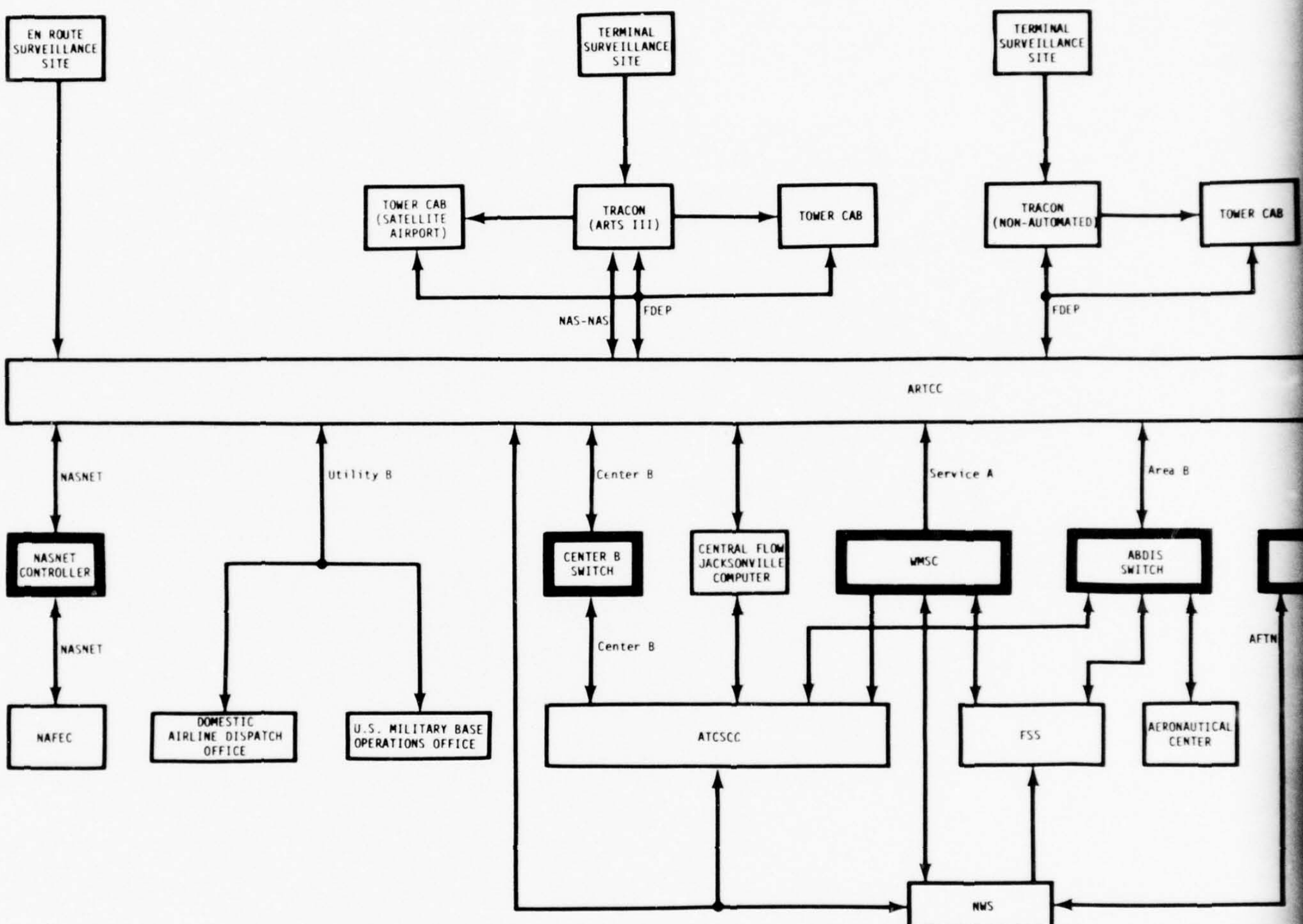
In the Near Term, the improvements expected in the approach and landing navigation facilities include the replacement of vacuum tube equipment used in the Instrument Landing System (ILS) with solid state equipment. In the Far Term (Figure 2-20), it is anticipated that the Time Reference Scanning Beam Microwave Landing System (MLS) would be implemented. Due to its high (C-Band) frequency, MLS is not as susceptible to interference from nearby structures or terrain. Such interference precluded the installation of ILS in some locations due to questions of economical feasibility. MLS would make landing guidance economically feasible at such airports. The MLS system will also provide highly accurate horizontal and vertical guidance signals over a large volume of approach airspace. This would allow properly equipped aircraft the use of specifically defined curved approach procedures under instrument as well as visual meteorological conditions.

MLS would be provided with a digital link capability for improving the quality of the guidance signal transmitted to the aircraft. Other data such as runway visibility and status would also be transmitted. However, this uplink is not an all purpose digital link for the transmission of ATC messages.

2.8 Communications Facilities

2.8.1 Data Communications Facilities

Figure 2-21 presents a brief illustration of the current connectivity of various FAA facilities through the existing data communications networks. The FAA is planning to replace these existing data networks with a more efficient data communication system called the National Data Interchange Network (NADIN).


EN ROUTE SURVEILLANCE SITE
TERMINAL SURVEILLANCE SITE
TERMINAL SURVEILLANCE SITE
TOWER CAB (SATELLITE AIRPORT)
TRACON (ARTS III)
TOWER CAB
TRACON (NON-AUTOMATED)
TOWER CAB
NAS-NAS
FDEP
FDEP
ARTCC
NASNET
Utility B
Center B
Service A
Area B
NASNET CONTROLLER
CENTER B SWITCH
CENTRAL FLOW JACKSONVILLE COMPUTER
WMSC
ABDIS SWITCH
NASNET
Center B
AFTN
NAFEC
DOMESTIC AIRLINE DISPATCH OFFICE
U.S. MILITARY BASE OPERATIONS OFFICE
ATCSCC
FSS
AERONAUTICAL CENTER
NWS

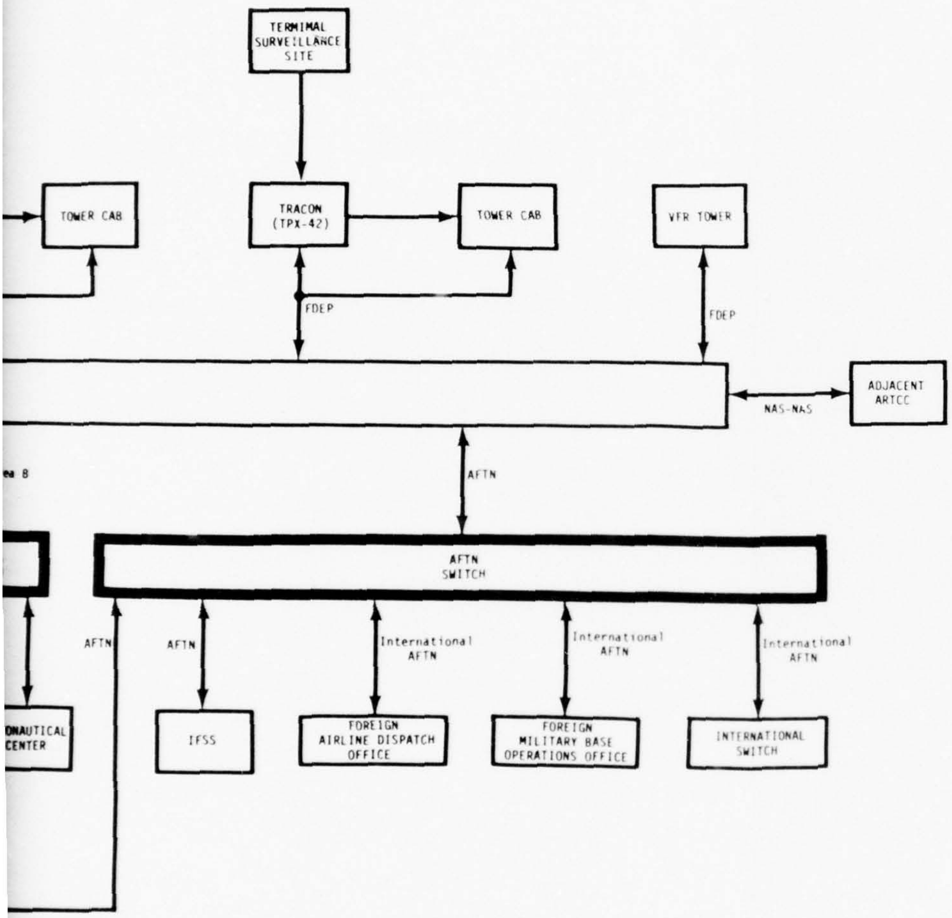
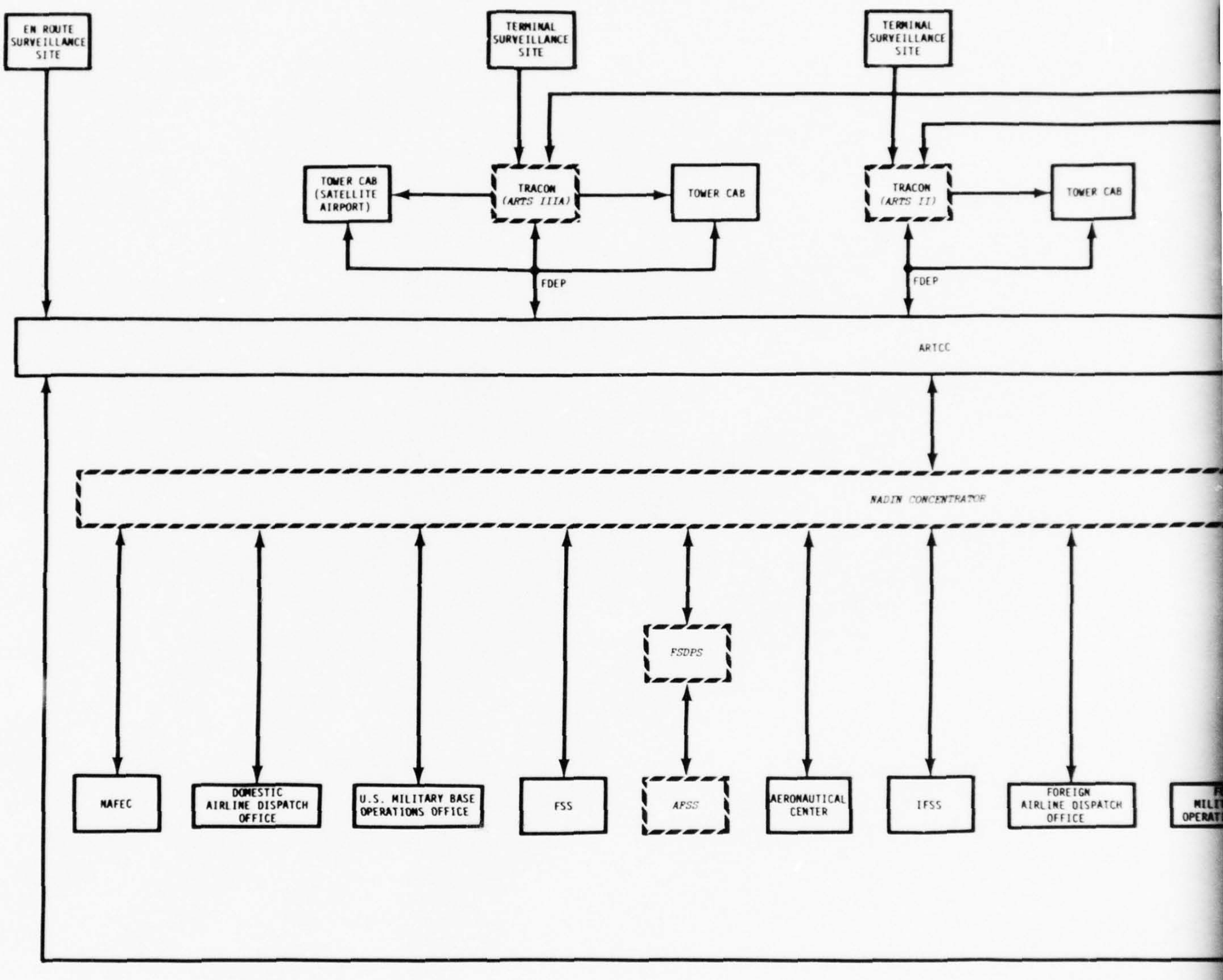


FIGURE 2-21
CURRENT DATA COMMUNICATIONS

NADIN would allow any user who has access to NADIN to communicate with any other user through the use of data concentrators and two centrally located switches. NADIN could result in the reduction in the number of data terminal devices at certain busy facilities, a reduction in the number of communications lines, and a more efficient utilization of the communication medium as a whole. The NADIN implementation is initiated through the NADIN I program, which would be followed by the NADIN II and the NADIN III phases. Subsequent phases would be defined at a later date.

2.8.1.1 Near Term Improvements

In the Near Term, NADIN I and NADIN II would be implemented. Figure 2-22 illustrates the data connectivity of the various facilities at that time. With the implementation of NADIN I and NADIN II, the data transmissions between en route centers and between en route centers and the terminal areas they service would be conducted through NADIN. NADIN would also provide communications to the Flight Service Facilities, military baseops, VFR towers and airline offices. Some of the data input/output equipment used today would continue to be used and some others would be upgraded, but the transmission medium would be provided by NADIN. The automated terminal facilities (ARTS III and ARTS II) are expected to have two links through NADIN. One is a link between the ARTS computers and the center computers, and the other one is a link between the FDEP at the terminal facilities and the en route computers. In addition, all three teletypewriter circuits (Area B, Utility B, and Center B), would be replaced with transmission and switching by NADIN. The ATCSCC would in the Near Term utilize the NADIN network for the connectivity between the Central



NOTE: Changes from the Current system to the Near Term are indicated in *italics*.

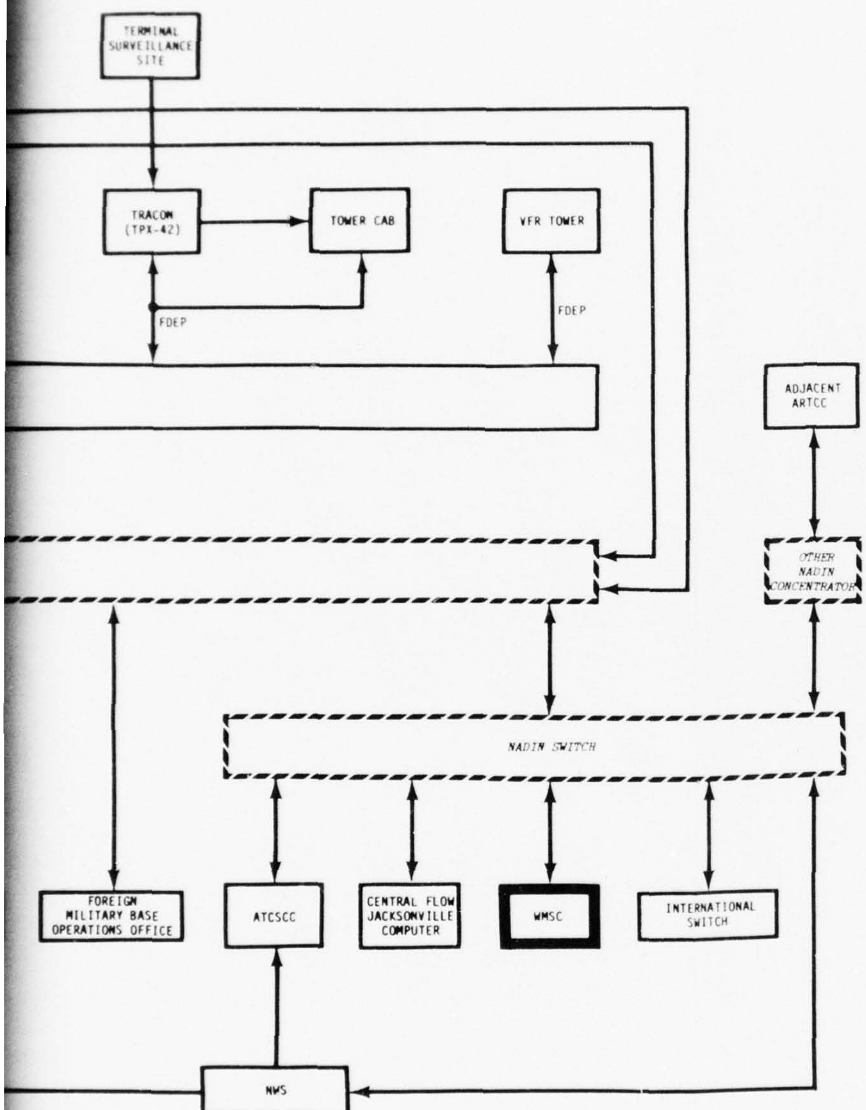


FIGURE 2-22
EXPECTED NEAR TERM DATA COMMUNICATIONS

Flow Control facility at Jacksonville and the Command Center at FAA Headquarters in Washington, D.C. NADIN would also provide connectivity between the FSS facilities and WMSC. The latter would also be connected through NADIN to NWS and the FSDPS.

2.8.1.2 Far Term Improvements

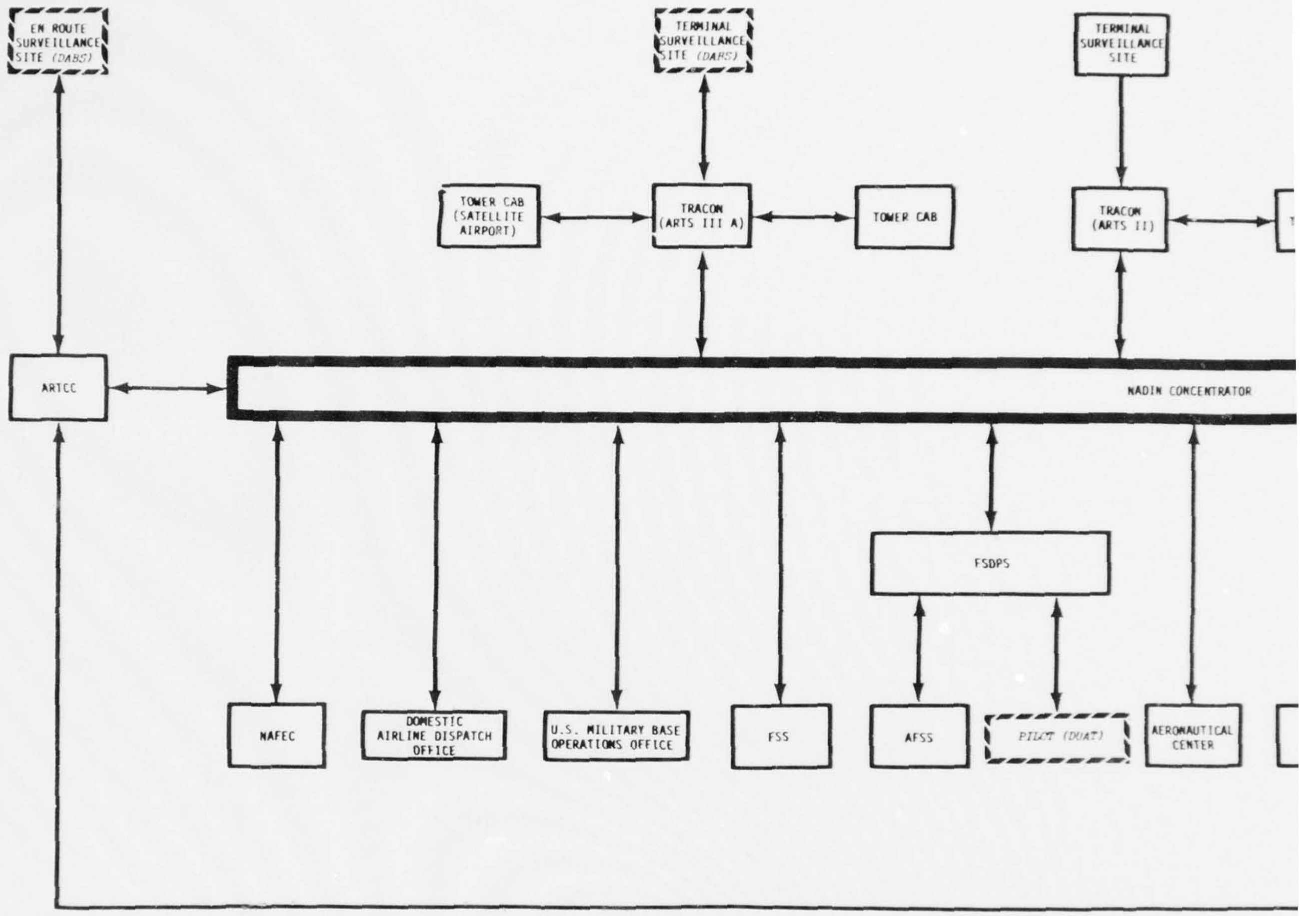
The NADIN III system is expected to be implemented as part of the Far Term system. The data connectivity between various FAA facilities at that time period is shown in Figure 2-23. It is expected that there would be no need for the Computer B network as a backup, as NADIN alone could be capable of providing the ARTCC-ARTCC connectivity. In addition, the FDEP equipment would be removed from automated terminal facilities and replaced by a 2400 bps data rate link that connects the center and the terminal computer facilities through TIPS. Terminal and en route surveillance sites would continue to be connected to the TRACONs and the en route centers through dedicated circuits. NADIN III would supply the connectivity between the AWP and the Flight Service facilities. If there were consolidation of flight services, the FS Hub would be connected to the ARTCC through the NADIN system.

2.8.1.3 Other Potential Improvements

Future changes in data communications are expected to be designed within an overall conceptual plan providing for an integrated FAA communication system. Such an integrated system would have Data, Radio, and Ground-Ground Voice Subsystems.

2.8.2 Voice Communications Facilities

Figure 2-24 briefly illustrates the current connectivity between various FAA facilities via the voice communications systems.



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

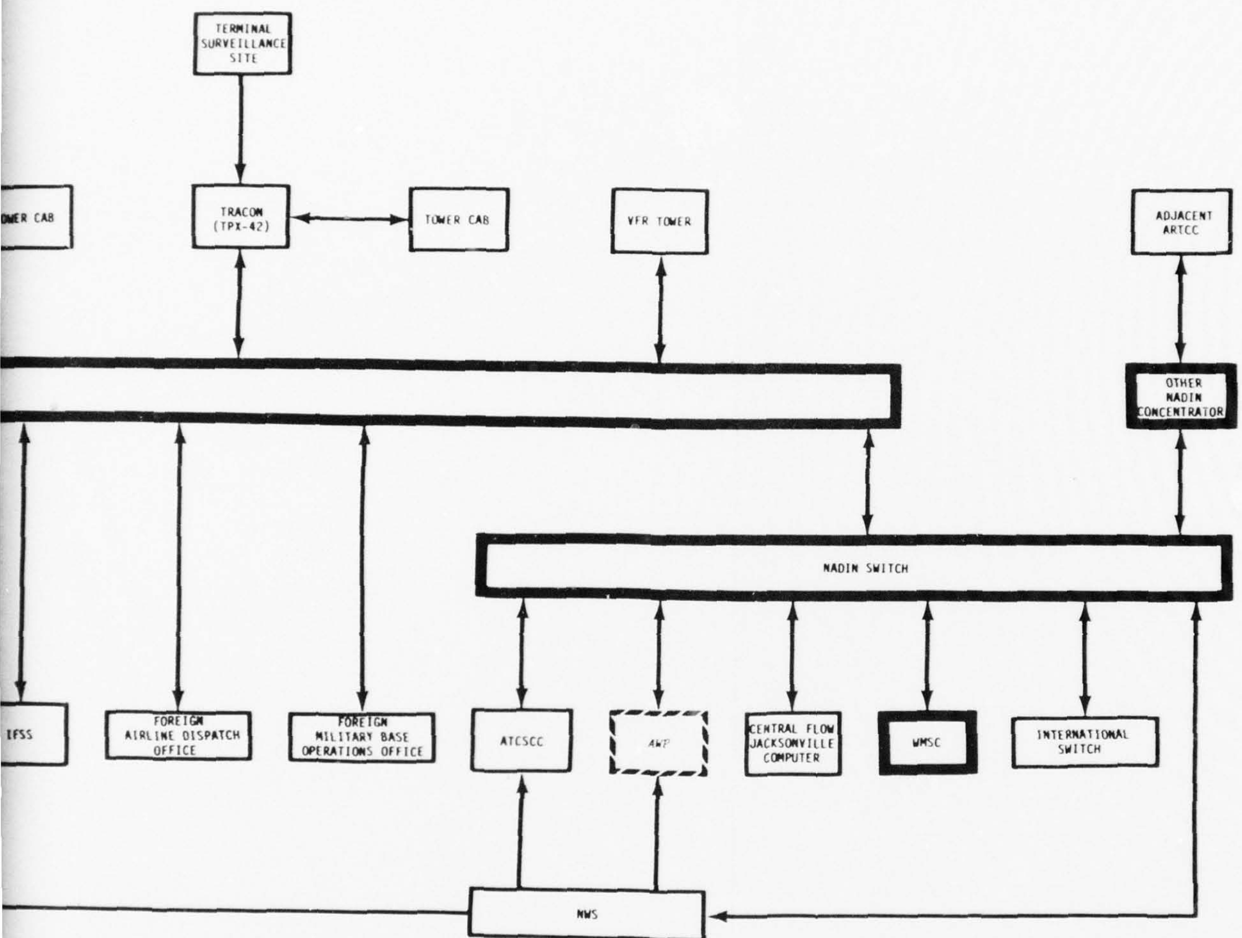


FIGURE 2-23
EXPECTED FAR TERM DATA COMMUNICATIONS

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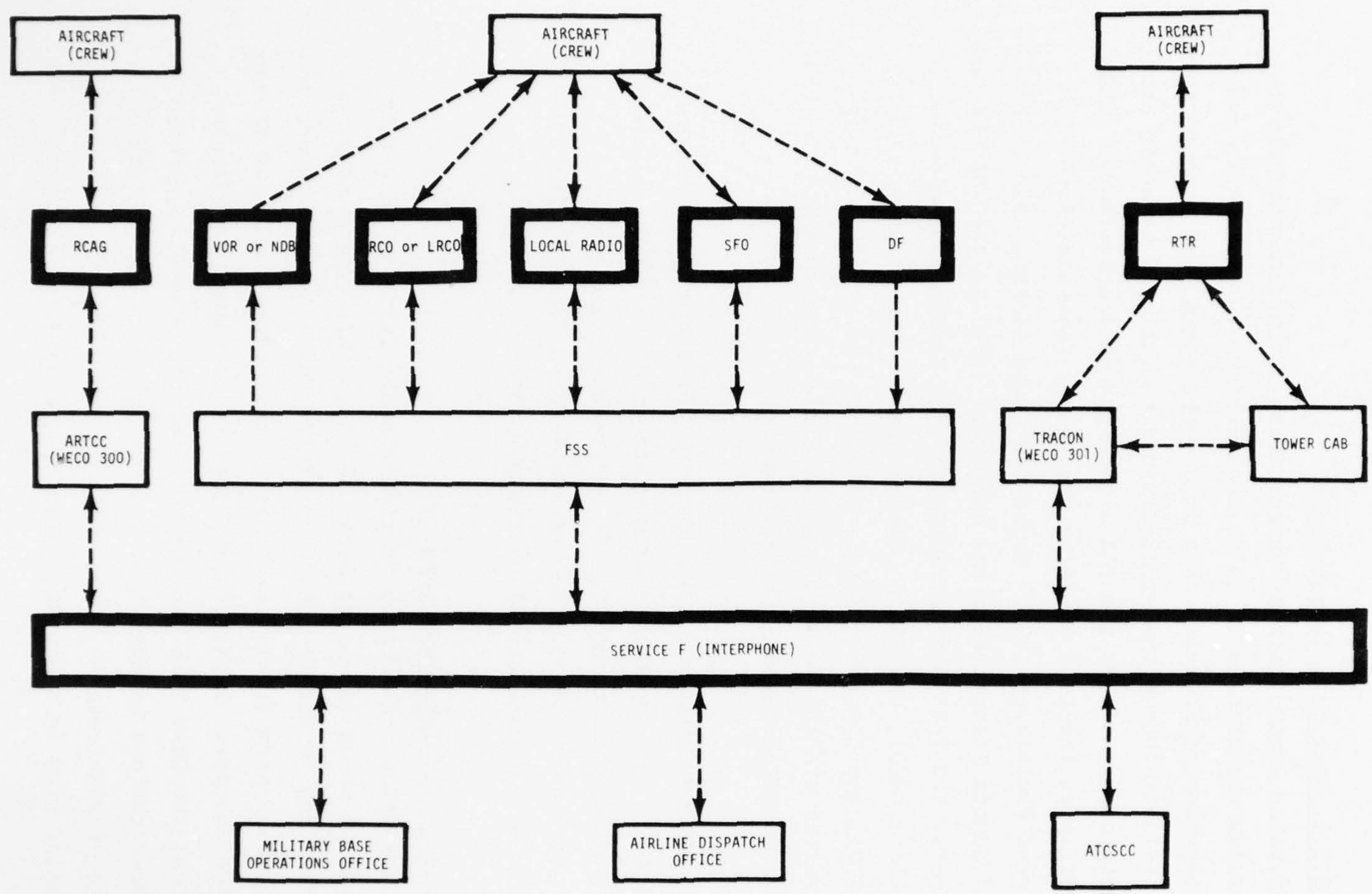


FIGURE 2-24
CURRENT AND NEAR TERM VOICE COMMUNICATIONS

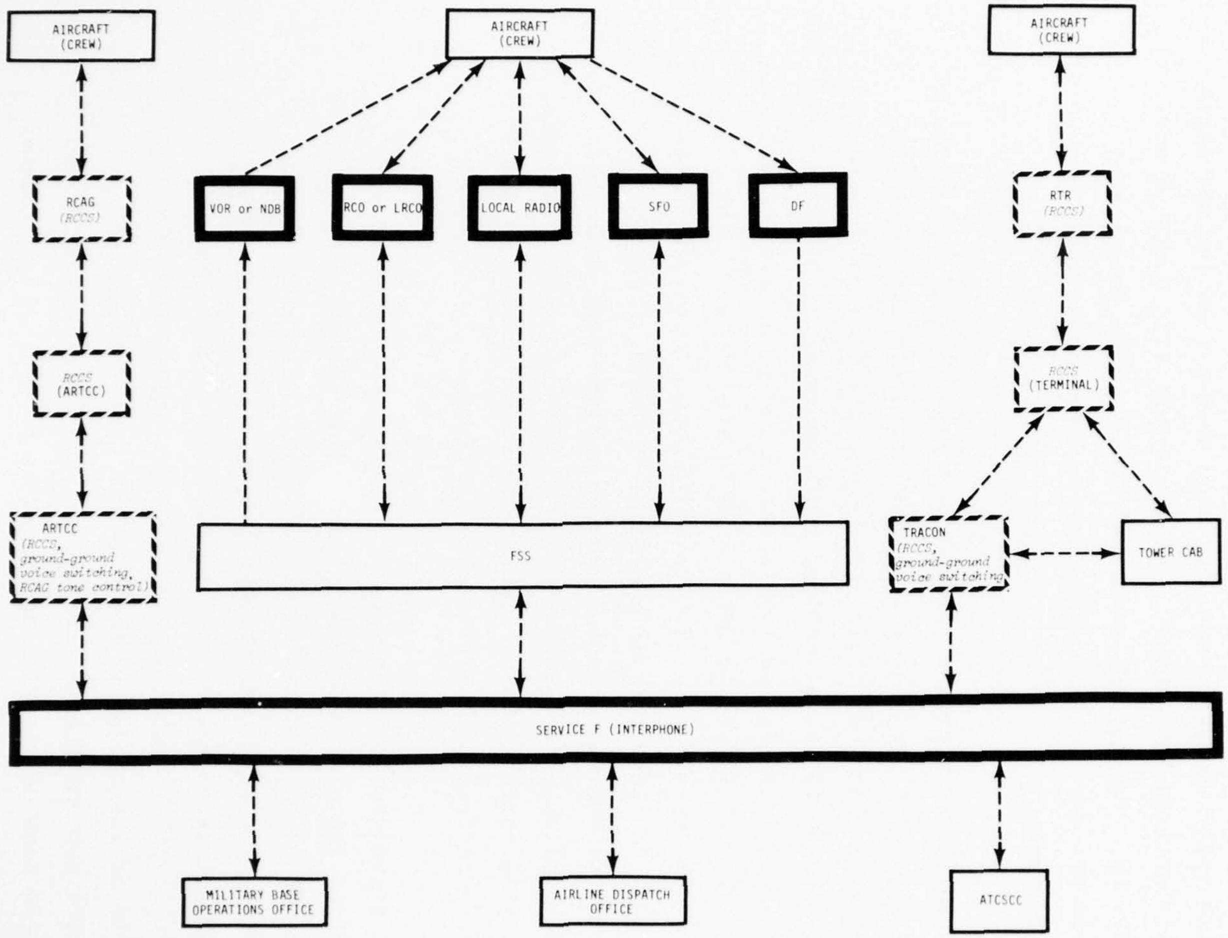
2.8.2.1 Near Term Improvements

The voice communications connectivity in the Near Term system remains the same as it is in the Current system. There are improvements, however, that impact the air-ground communications. It is anticipated that radios would be replaced by solid state equipment in all of the FAA air-to-ground transceivers. The facilities involved would be the Remote Communications Air-Ground Facilities (RCAG) in the en route system, local radios and Remote Transmitters and Receivers (RTR) in the TRACONs and towers, the FSSs' local radios and the Remote Communications Outlets (RCO), the FSS's Limited Remote Communications Outlet (LRCO), and the FSS's Single Frequency Outlet (SFO). Also involved are the FSS's direction finder receivers and the FSS's VOR/NDB voice channel transmitters.

The availability/maintainability of the RCAGs would be enhanced by the expected implementation of the Remote Maintenance Monitoring System (RMMS). In addition to remote monitoring, the RMMS would provide record keeping and trend analysis and would make remote certification possible.

2.8.2.2 Far Term Improvements

The expected voice communications connectivity in this time frame is shown in Figure 2-25. A basic improvement under consideration is the introduction of the Voice Communications and Control System (VSCS) which has an integrated radio and ground voice concept. This program consists of three ingredients: first, the RCAG Tone Control Replacement; second, the Radio Communications Control System (RCCS); and third, the Ground Voice Communications component. The RCAG Tone Control Replacement program is aimed at replacing the outdated equipment used



NOTE: Changes from the Near Term system to the Far Term are indicated in *italics*.

FIGURE 2-25
EXPECTED FAR TERM VOICE COMMUNICATIONS

for remotely controlling the RCAG transceivers for functions such as main/standby selection or frequency selection. New solid state equipment would be used which could include digital signaling techniques. The throw-away cost would be minimized by a modular design of the Tone Control Replacement equipment and by making this system compatible with the RCCS/VSCS system.

The RCCS is expected to provide the link (and in many cases is a remote link) between the en route and terminal facilities on the one hand and their air-to-ground radios on the other. Assuming no FS consolidation, there would be no RCCS component for the flight service facilities; however, should the decision to consolidate be made, an RCCS subsystem for the FS Hub would be implemented. RCCS could provide inband digital signaling, and like the NADIN system, it would provide a more efficient communications medium to replace many dedicated lines and networks. RCCS also provides automated monitoring, reconfiguration, trunk restoral functions as well as main/standby selection and frequency selection.

The ground voice components of the VSCS are expected to replace the electromechanical switching systems consisting of the WECO 300 at the ARTCC and the WECO 301 at the terminal areas. The detailed concepts for the replacement systems have not been defined as yet, but they are expected to include some level of technical control. New higher gain antennas would be introduced in the Far Term system in all the air-ground communications facilities. The antennas would incorporate some directivity and would be ruggedized and radomed. Another Far Term improvement expected at low level towers is the implementation of the Small Voice Switching System (SVSS)

which is an integrated radio and ground voice system that provides signaling, switching, monitoring and reconfiguration and trunk restoral.

2.8.2.3 Other Potential Improvements

As an alternative to the VSCS integrated system concept, the FAA has been considering separate and independent voice systems: an air-ground system (an independent RCCS) and a ground voice communication system. The long range view at the FAA is to eventually attain an integrated communications system capability which incorporates not only radio and ground voice, but also data communications. Furthermore, the FAA may consider extending the implementation of these improvements to the FSS facilities.

2.9 Avionics

Certain of the changes in the ATC system call for associated changes in avionics in some of the aircraft using the system. The purpose of this section is to describe the avionics changes implied by the ATC improvements stated in this document. It is anticipated that there will be many other airborne improvements in the areas of flight control systems, auto pilots, and navigation instrumentation. However, these will not be discussed here since they are outside the scope of this report.

No change from ATCRBS transponders to DABS transponders would be required for a large majority of the users of the airspace but a gradual transition from the ATCRBS transponders to DABS transponders is expected. However, implementation of ATARS would require the use of a DABS transponder and an ATARS display for those aircraft wishing to receive the ATARS

collision avoidance service and flying in airspace where the ATARS service is provided. In general, to receive the ATARS service both aircraft must be within the surveillance coverage of the DABS site, at least one of the two aircraft must have an ATARS display and the other aircraft must have at least an ATCRBS beacon with altitude readout.

One improvement for additional collision avoidance which would require new avionics for users desiring the service is the Beacon-based Collision Avoidance System (BCAS). It is anticipated that BCAS avionics would be compatible with DABS and would be installed in most air carrier and high performance general aviation aircraft. In current concepts, BCAS may have several modes of operation. The utility of the various modes depends on the degree of surveillance coverage where the aircraft is operating. Initially, it is anticipated that the active BCAS mode would be implemented. In this mode, BCAS would interrogate transponders within BCAS operating range (20 miles). In other modes, BCAS does not interrogate other aircraft but monitors interrogations from ground based ATCRBS and DABS sites and monitors the replies of aircraft to these interrogations. The full BCAS capability is expected to combine both features. The full BCAS philosophy has resulted from a desire to minimize potential interference with the regular operation of ATC surveillance in a full spectrum of ATC environments ranging from high density to low density.

The details of the current BCAS conceptual design may change in time as its role relative to other FAA collision avoidance systems gets better defined. But, regardless of the detailed design, BCAS is expected to perform calculations, based on

information available to the airborne system, which would lead to a prediction of conflict on the basis of close proximity and short lookahead encounters. Collision avoidance assistance is provided to any aircraft equipped with BCAS equipment if the other aircraft has an ATCRBS transponder with altitude reporting capability and if both aircraft are operating within airspace where BCAS is expected to work.

The availability of the DABS Data Link for the communications of DABS and ATARS messages, makes it also available for the transmission of other ATC and advisory messages. A candidate set of additional messages that is currently being considered by the FAA for transmission via the data link includes altitude confirmation, hazardous weather advisories, MSAW advisories, take-off clearance confirmation, and real time surface winds. The specifics as to what will be displayed and how to display it are still in the definition phase; however, it is expected to require some additional avionics over and above that required by the DABS/ATARS and BCAS systems.

Providing the pilot with a display of traffic information in airspace adjacent to the aircraft is also currently being discussed as a potential improvement. The work aimed at defining this future display is being done under the Cockpit Display of Traffic Information (CDTI) program. The concepts generally proposed for the use of the CDTI range from pilot centered control concepts (strategic) to concepts that are an extension of the current ground based ATC system where more information is made available to the pilot, but control is maintained from the ground.

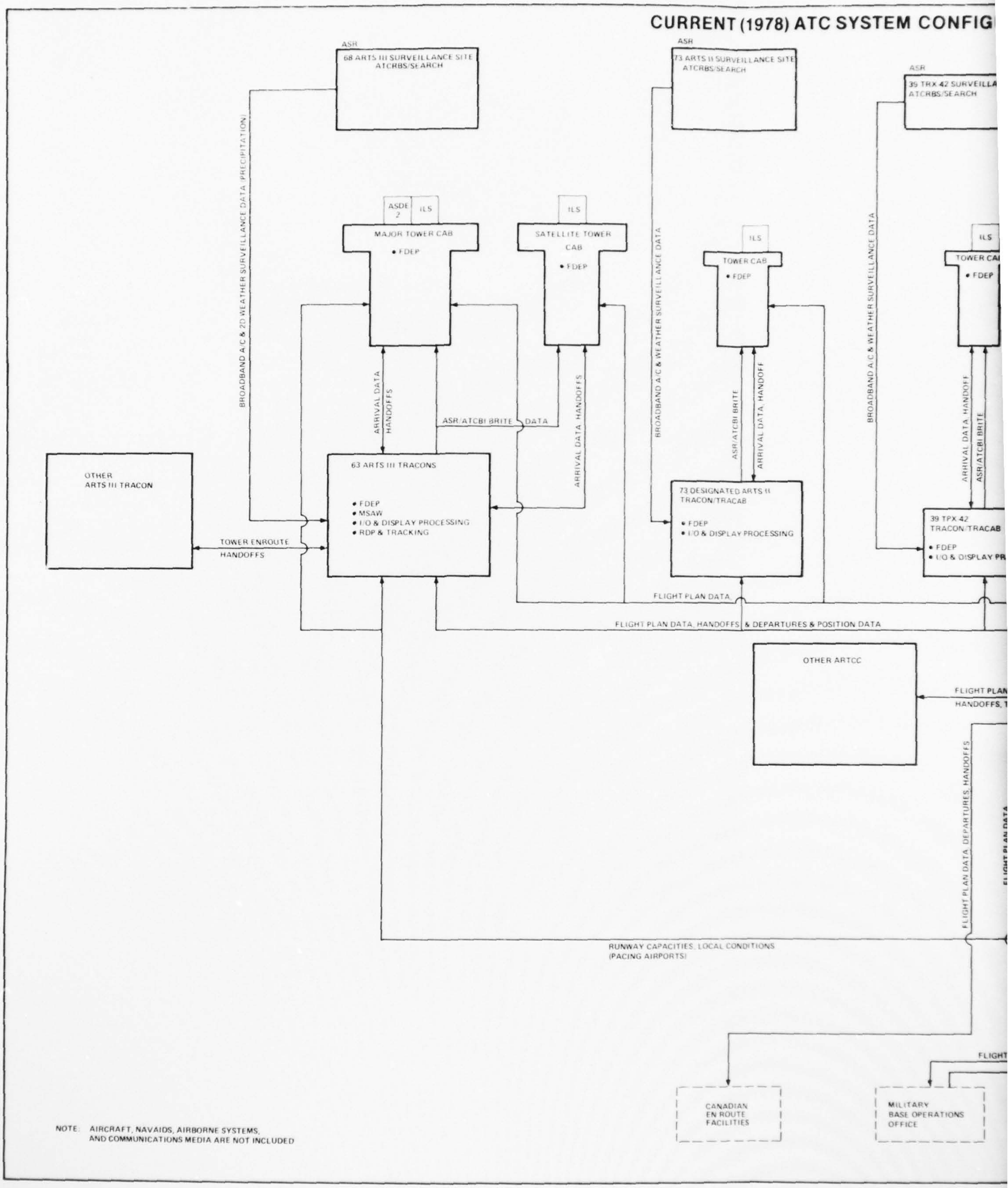
Various levels of avionics capabilities for the MLS system are expected in the Far Term. The minimum level capability provides deviations from azimuth and glide slope. The more sophisticated capability expected for air carriers would enable curved approaches and would include angle and other guidance messages for use by existing onboard computers such as the RNAV and Flare systems. For example, local way-points could be broadcast by the MLS uplink. Similarly, other approach and landing data could potentially be sent to the aircraft on the MLS data channel which is a one way link from the ground to the aircraft.

A potential future improvement is the implementation of the Head Up Display (HUD) to provide the pilot with visual cues as to whether the aircraft is above, below or on the glide path during descent.

3. ATC SYSTEM CONFIGURATION

This section presents an overall system description of the improvements for each facility class described in Section 2. It illustrates how these improvements fit together as a complete ATC system in the various time frames considered. Figures 3-1, 3-2, and 3-3 present an overview of the ATC system configuration in the Current time period, in the Near Term and in the Far Term, respectively. The ATC facilities in these figures, from top to bottom, are as follows: surveillance sites, tower cabs, TRACONS, ARTCCs, flight service facilities and system elements interfacing with them, and the ATC System Command Center. At the bottom of the charts are presented non-ATC facilities that interact significantly with the ATC system. The direction of flow of information from one facility to another is also indicated.

The block representing each one of the facilities has indicated in it the significant ATC system functions that are performed within the facility. The Near Term and Far Term improvements are also indicated within the facility blocks in Figures 3-2 and 3-3, respectively. The impact of these improvements on the functional flow of information is indicated in the figures in the appropriate time frame. A specific change from one time frame to another is highlighted by shaded areas and italics if the changes are within a facility. The impact of changes on the information flow is indicated by the use of italics. It should be noted that these figures are intended to highlight changes and improvements and they are not meant to be exhaustive in depicting capabilities, information flow, or connectivity. Thus, some systems features that do not change with the time were not included in the illustrations. Furthermore, Figure 3-1 presents only a brief listing of the capabilities of the Current system, since these capabilities are used only as a


CURRENT (1978) ATC SYSTEM CONFIG
ASR
68 ARTS III SURVEILLANCE SITE ATCRBS/SEARCH
ASR
73 ARTS II SURVEILLANCE SITE ATCRBS/SEARCH
ASR
39 TRX 42 SURVEILLA ATCRBS/SEARCH
BROADBAND A/C & 2D WEATHER SURVEILLANCE DATA (PRECIPITATION)
BROADBAND A/C & WEATHER SURVEILLANCE DATA
BROADBAND A/C & WEATHER SURVEILLANCE DATA
ASDE 2
ILS
MAJOR TOWER CAB
• FDEP
ILS
SATELLITE TOWER CAB
• FDEP
ILS
TOWER CAB
• FDEP
ILS
TOWER CA
• FDEP
ARRIVAL DATA HANDOFFS
ASR/ATCBI BRITE DATA
ARRIVAL DATA HANDOFFS
ASR/ATCBI BRITE
ARRIVAL DATA, HANDOFF
ARRIVAL DATA, HANDOFF
ASR/ATCBI BRITE
OTHER ARTS III TRACON
TOWER ENROUTE HANDOFFS
63 ARTS III TRACONS
• FDEP
• MSAW
• I/O & DISPLAY PROCESSING
• RDP & TRACKING
73 DESIGNATED ARTS II TRACON/TRACAB
• FDEP
• I/O & DISPLAY PROCESSING
39 TPX 42 TRACON/TRACAB
• FDEP
• I/O & DISPLAY PR
FLIGHT PLAN DATA
FLIGHT PLAN DATA, HANDOFFS & DEPARTURES & POSITION DATA
OTHER ARTCC
FLIGHT PLAN
HANDOFFS, T
FLIGHT PLAN DATA, DEPARTURES, HANDOFFS
RUNWAY CAPACITIES, LOCAL CONDITIONS (PACING AIRPORTS)
FLIGHT
CANADIAN EN ROUTE FACILITIES
MILITARY BASE OPERATIONS OFFICE
NOTE: AIRCRAFT, NAVAIDS, AIRBORNE SYSTEMS, AND COMMUNICATIONS MEDIA ARE NOT INCLUDED

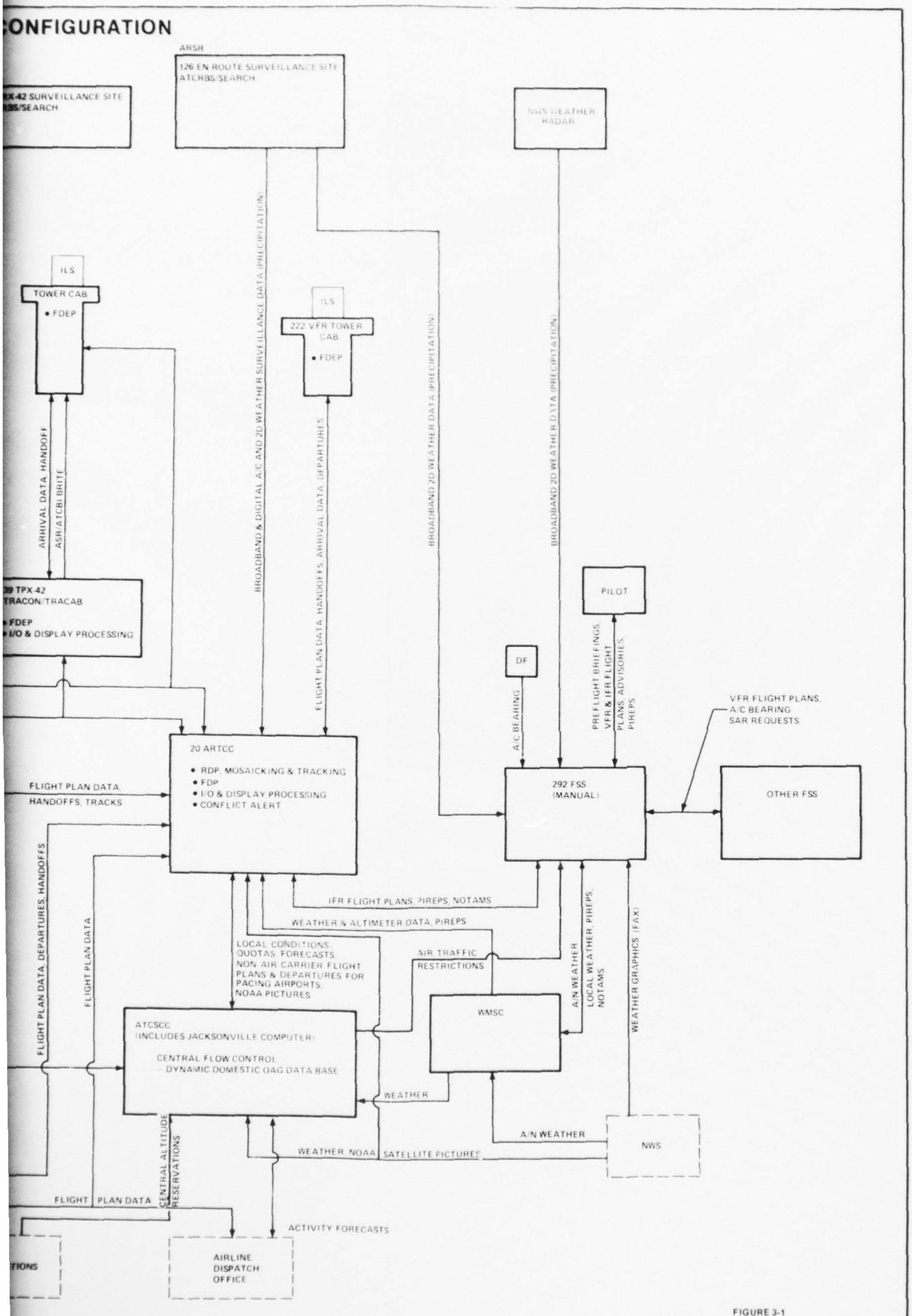
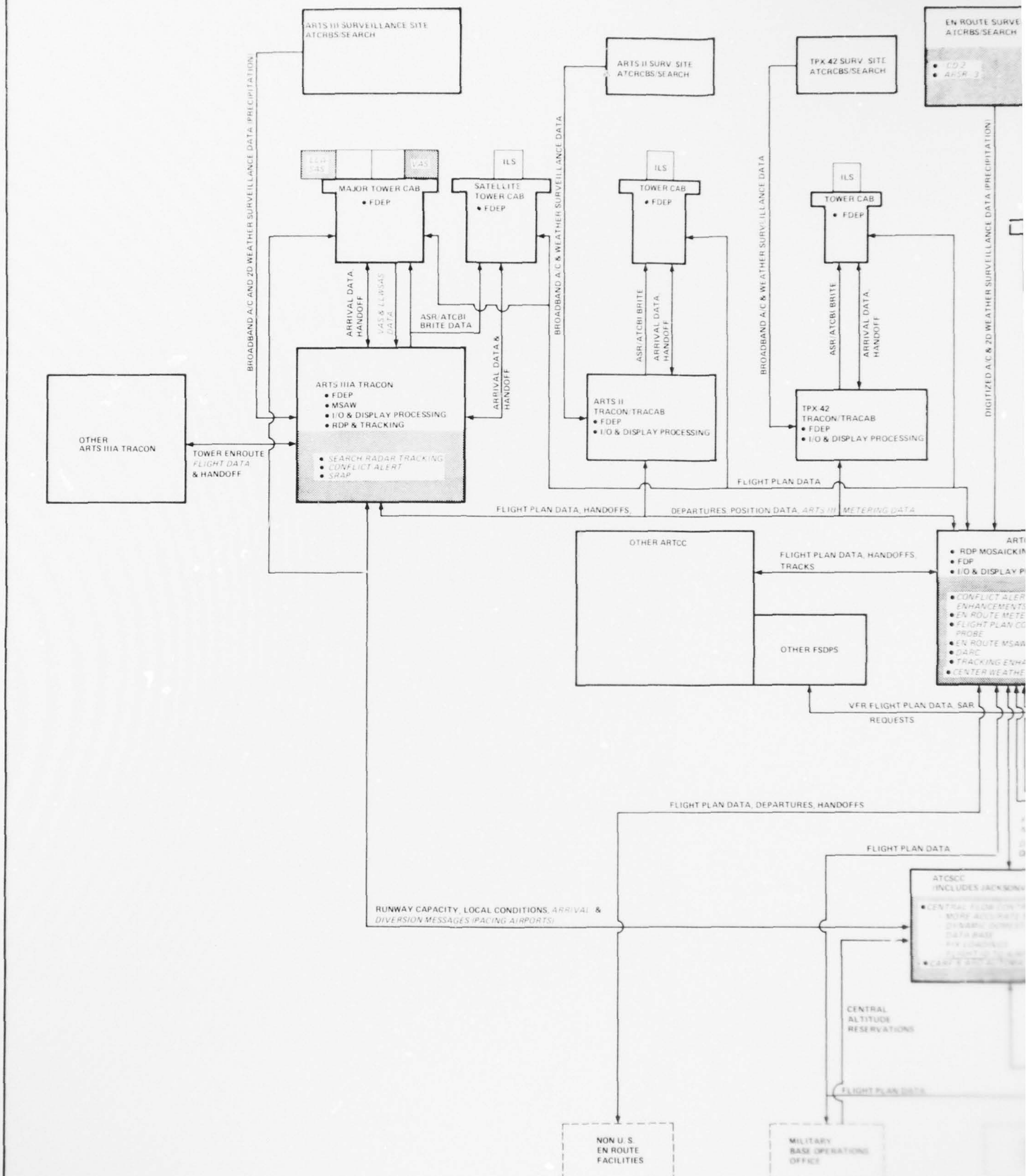


FIGURE 3-1
CURRENT (1978) ATC SYSTEM CONFIGURATION

NEAR TERM (1979-1982) ATC SYSTEM CONFIG



NOTE: AIRCRAFT, NAVAIDS, AIRBORNE SYSTEMS
AND COMMUNICATIONS MEDIA ARE NOT INCLUDED
SHADING/ITALICS INDICATE SYSTEM IMPROVEMENTS IN NEAR TERM

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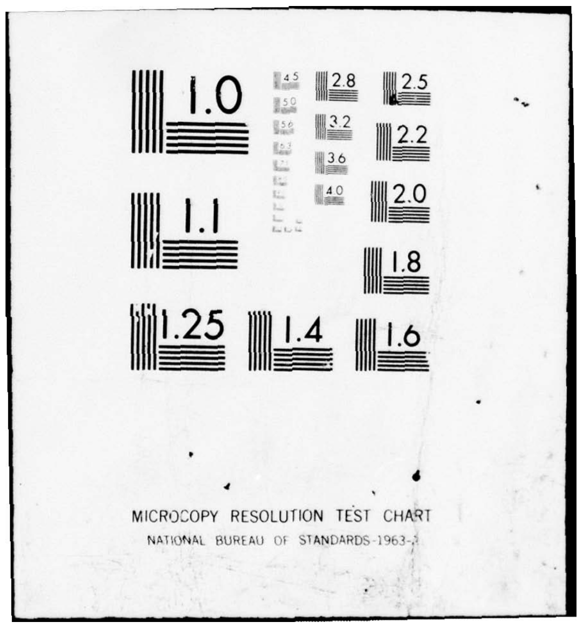
1.0
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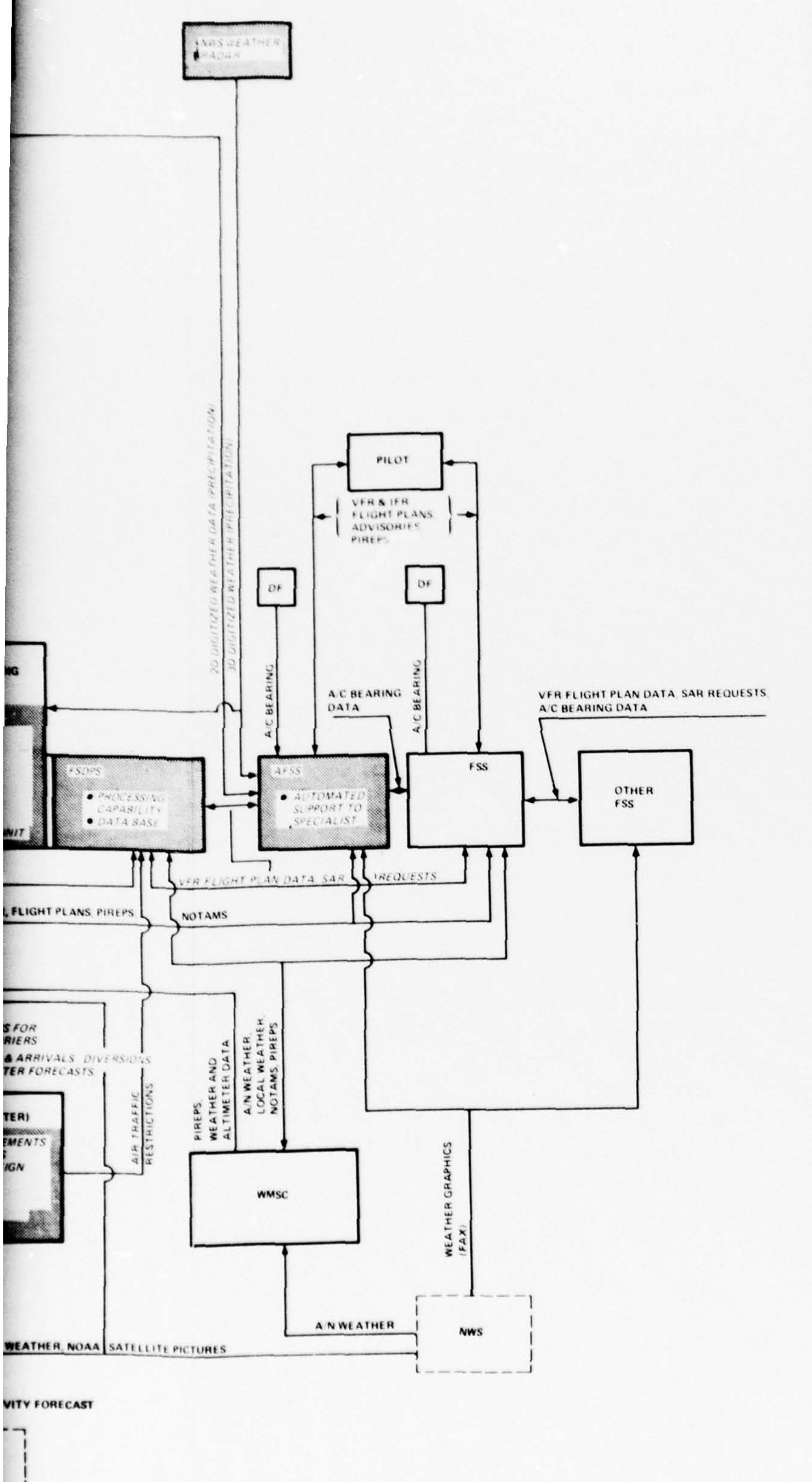
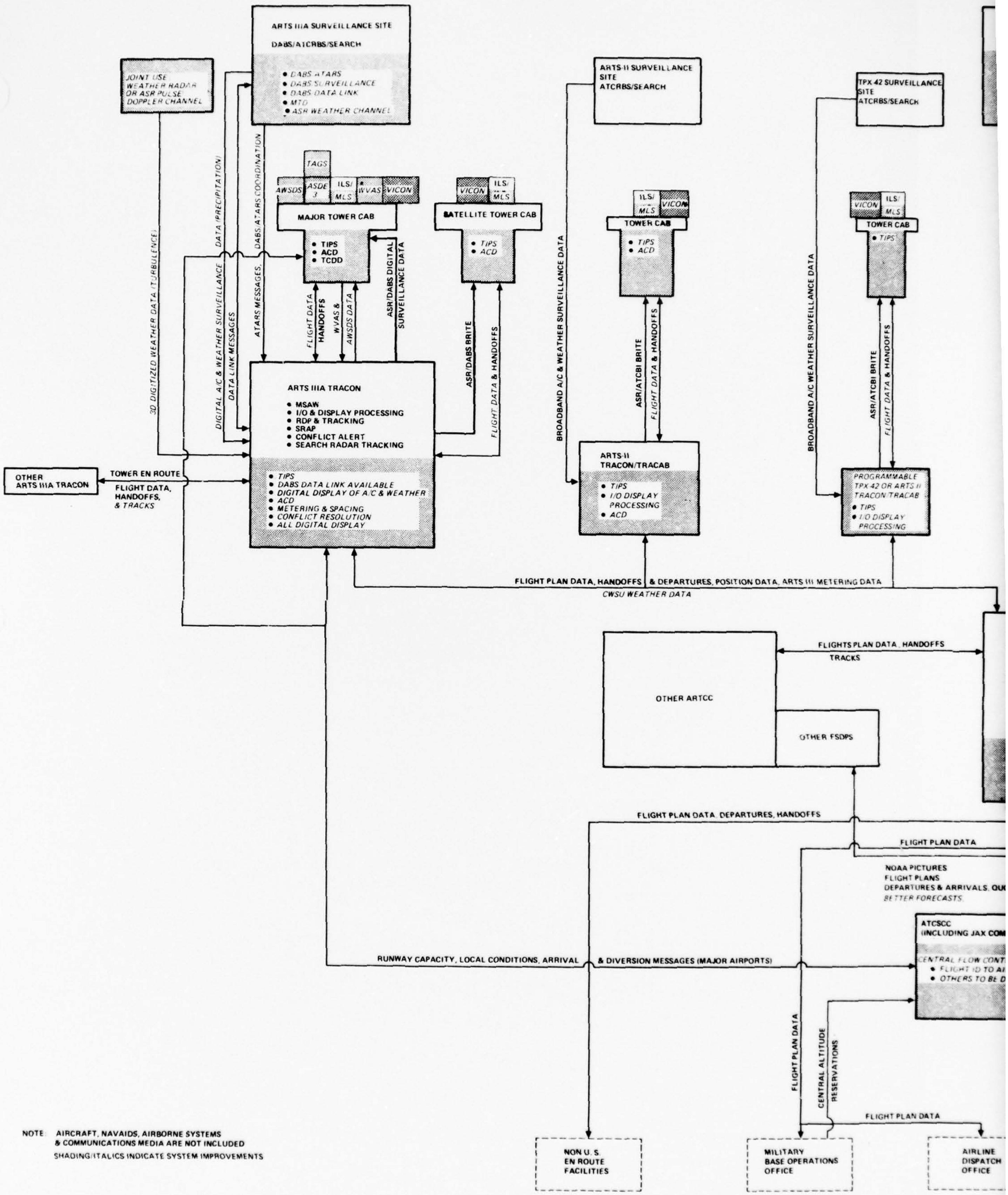


FIGURE 3-2
NEAR TERM (1979-1982) ATC SYSTEM CONFIGURATION

FAR TERM (POST 1982) ATC SYSTE



NOTE: AIRCRAFT, NAVAIDS, AIRBORNE SYSTEMS & COMMUNICATIONS MEDIA ARE NOT INCLUDED

SHADING/ITALICS INDICATE SYSTEM IMPROVEMENTS

TEM CONFIGURATION

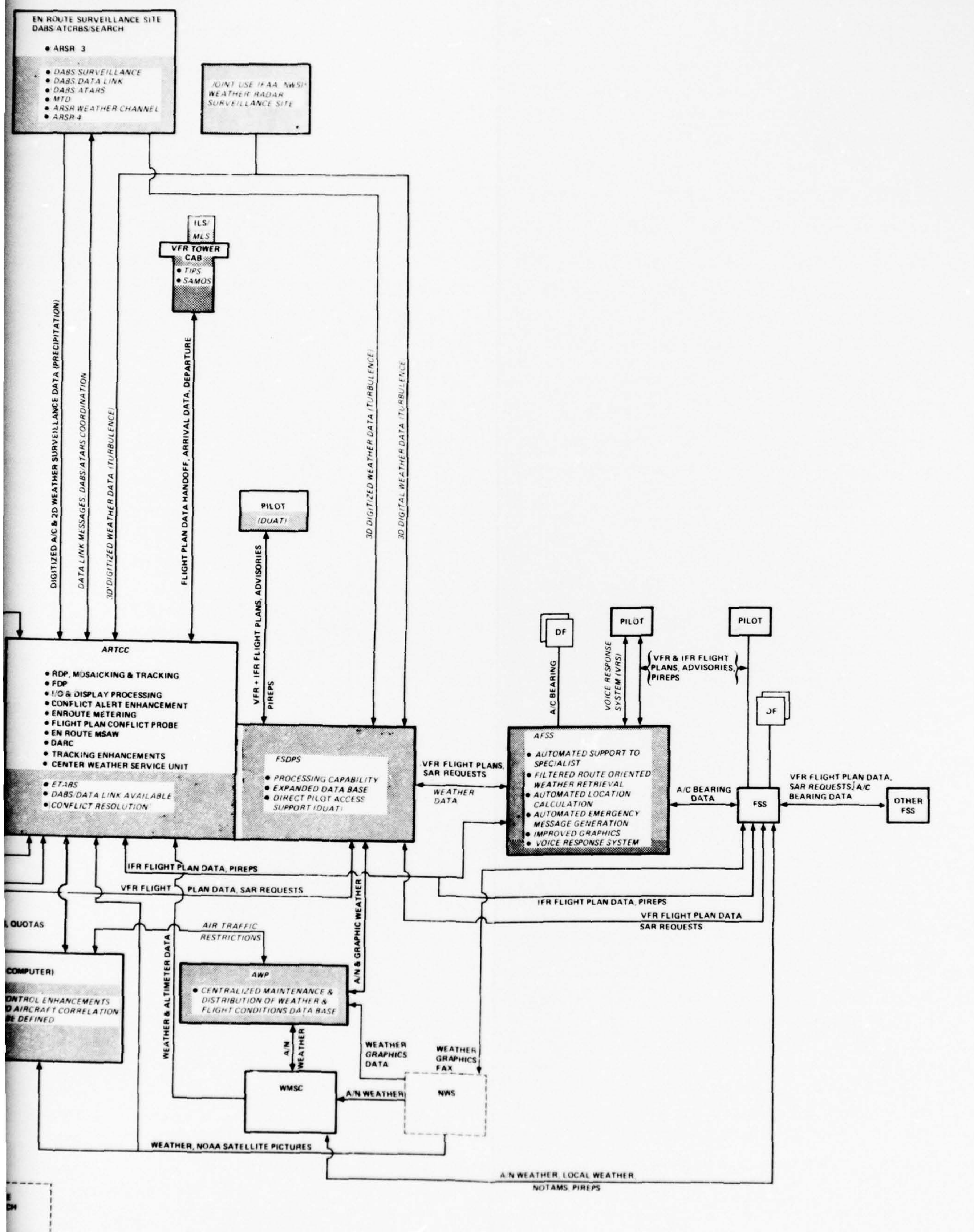


FIGURE 3-3
FAR TERM (POST 1982) ATC SYSTEM CONFIGURATION

starting point for describing the future improvements. For example, the capabilities currently resident in the NAS Stage A system have been summarized by the following: Radar Data Processing (RDP), Mosaicking and Tracking, Flight Data Processing (FDP), Input/Output and Display Processing, and Conflict Alert.

Finally, the number of each type of facility at the present time is shown in Figure 3-1. For example, there are currently 126 en route search radars. The numbers of facilities are not indicated in future periods because of the uncertainty associated with the deployment of various system elements.

The following is a listing of the major deployment assumptions made in developing the expected future ATC system configurations:

- The DABS capability would be achieved through a direct transition from ATCRBS to DABS, instead of an evolutionary transition which would result in developing an interim monopulse detection and processing capability.

- Surveillance improvements, including DABS, would be introduced throughout the En Route System and throughout all of the ARTS III surveillance sites. No improvements were assumed for surveillance sites associated with lower level TRACONs. Search radar surveillance information is expected to remain an ATC requirement in both the en route and terminal environments. The ATARS collision avoidance service would be implemented in both En Route and ARTS III terminal facilities. Similarly, the DABS Data Link

capability would be available for the relay of ATC messages and advisories at all facilities where DABS is deployed.

- Digitized three dimensional weather information from the NWS weather radar would be made available in the Near Term to the Center Weather Service Unit (CWSU) at the ARTCC and also to some of the flight service facilities. In the Far Term, the Joint Use Weather Radars would provide not only digitized three dimensional weather data but also some information on weather turbulence. This weather data would be obtained through the implementation of sophisticated doppler techniques at the joint use radars. These radars would provide weather turbulence information to the Flight Service Data Processing System (FSDPS), to the ARTCCs and to some ARTS III TRACONs. Other ARTS III TRACONs would have weather turbulence data through modifications of the terminal radars to include pulse doppler radar techniques.

- In the Near Term, weather surveillance information is provided to some flight service facilities (those with an EFAS position) either from the NWS weather radar or from the en route surveillance radars, depending on convenience of access. In the Far Term, the availability of weather data would no longer be limited to the EFAS position: any specialist position at the AFSS would have access to weather radar data from the FSDPS.

- The Vortex Avoidance System and the Low Level Wind Shear Alert Systems would be deployed at some of the high activity airports. In the Far Term, these

capabilities would be upgraded to the Wake Vortex Avoidance System and the Advanced Wind Shear Detection System. The ASDE-3 radars would replace the ASDE-2 at some of the high activity airports and would be deployed at others that currently have no airport surface detection radars. The Tower Automated Ground Surveillance (TAGS) Systems which would augment the ASDE-3 broadband information by alphanumeric aircraft identity are assumed to be limited in deployment to a few high activity airports.

- In the Far Term, new installations of landing systems would largely be MLS. Both MLS and ILS are expected to co-exist for some time.

- The Terminal Information Processing System (TIPS) would be deployed in all TRACONs and TRACAB facilities. TIPS would be located in the TRACON itself, but all towers associated with TRACONs would have access to it. FDEP equipment would thus be eliminated from all TRACONs and associated towers. A goal of the TIPS program is extending its implementation to VFR Tower Cab facilities.

- Deployment of terminal automation improvements, including Metering and Spacing, Conflict Alert, and Conflict Resolution Adivsory, would be limited to ARTS III facilities only.

- All of the ARTCC automation capabilities would be added to all CONUS en route centers. These capabilities are: Conflict Alert Enhancement, Conflict Resolution Advisory, En Route Metering, Flight Plan Conflict Probe, En Route MSAW, DARC, Tracking Enhancements, Electronic Tabular Display, DABS data link, and the CWSU.

- As implied in Figures 3-2 and 3-3, it was assumed in this report that there would be no flight service consolidation into 20 Hubs. It is assumed, however, that the Flight Service Data Processing Systems (FSDPS) would be implemented and would be colocated with the ARTCC. Each of the Automated Flight Service Stations (AFSS) would be directly associated with an FSDPS. In the Near Term the improvements provided to these facilities (AFSS/FSDPS) include automated support to the specialist in information retrieval and maintenance and in flight plan filing. In the Far Term it is assumed that pilots would have access to the data base through Direct User Access Terminals and the Voice Response/Recognition System. Furthermore, the accessed data base is provided with centralized maintenance and distribution of weather and flight conditions information.

- TRACON/TRACAB sites that currently have a TPX-42 capability would be upgraded either to an ARTS II or a programmable TPX-42 capability.

- Improvements provided to the Central Flow Control Function emphasize more real time data and more accurate simulations.

- The Airport Traffic Control Tower Consolidated Display (ACD) which consolidates status data currently available on numerous displays, would be deployed at ARTS III and ARTS II terminal areas, both in the tower cab and in the TRACON.

- The Tower Cab Digital Display (TCDD) would replace the BRITEs at primary tower cabs associated with ARTS III terminal areas. The TCDD would display digitized radar and alphanumeric information.

- The Remote Maintenance Monitoring System would be deployed to service the ARTCCs navigation, surveillance and air-ground communications facilities. A host processor would be deployed at each ARTCC to service the center's facilities. Separate RMMS processors are assumed to be deployed at the terminal facilities. These processors are associated with the Airport Traffic Control Tower Consolidated Display (ACD).

4. SINGLE THREAD OPERATIONAL DESCRIPTION

This chapter describes the sequence of events associated with an IFR air carrier flight departing from a high density airport, transiting en route airspace, and landing at a high density airport. It is recognized that the selection of any one type of flight for attempting to illustrate how the ATC system works falls far short of describing the full operational capability of the system. It does, however, help convey more understanding of the system than is possible in the facility oriented discussions in the previous chapters. Further, the use of the high density terminal areas as points of departure and landing, serves to illustrate most of the improvement features in an operational context. The single thread description is discussed from the viewpoint of the ATC system operational authority. Since it is impossible to cover all the possible ways in which various activities get accomplished, the discussions focus on a normal flight although some pertinent rare events are noted to illustrate how some exceptional events are handled.

The operationally oriented single thread was constructed under the assumption that the mode of operation within the ATC system would remain basically ground based. It is recognized, however, that in the longer term certain potential improvements such as AERA, full use of the data link, and possibly CDTI could cause significant changes in the methods of operation in the delivery of ATC services even within the constraints of the ground based ATC system.

The first section (Section 4.1) contains a narrative description of a single thread flight through the Current System. Section 4.2 addresses the changes that will take place when the Near Term

System is available. Section 4.3 illustrates the additional changes that will take place when the Far Term System is operational. A series of tables in Section 4.4 summarizes the same information presented in a narrative fashion in Sections 4.1, 4.2, and 4.3. In those tables, changes associated with a particular ATC function are highlighted by the use of an asterisk.

4.1 Current ATC System

Preflight Activities

Air carrier flight plans are bulk stored on magnetic tape in the computer of the en route center where the flight begins. These tapes are loaded daily into the en route automation system throughout the ATC system. Any changes or cancellations to these flight plans are communicated from the airline dispatch offices to the ARTCC and these changes are directly entered into the computers. At a certain time parameter prior to departure, the flight plan data is transmitted to the departure ARTS III facility: flight plan data is transmitted to the ARTS System, and flight strips which present pertinent information about the flight are printed by FDEP. Flight plan data is also transmitted through the en route computer-to-computer link to the adjacent en route facility where the flight is planned to enter after leaving the departure center. This flight plan is transmitted at a specified time parameter prior to center boundary crossing. Flight plan data is also transmitted from the ARTCC to the departure tower cab through FDEP at a specified time parameter before departure. The aircraft receives the Automated Terminal Information System (ATIS) information on the appropriate radio frequency. This information may include runways in use, departure routes in use, noise abatement procedures, terminal area weather, predicted departure delays and NOTAMs. A time parameter prior to departure, a flight strip carrying departure clearance information is

printed at the terminal departure sector and also at the tower cab. This information is then delivered to the aircraft by the clearance delivery position in the tower cab using the appropriate radio frequency. The clearance delivery position passes the flight strip to the ground control (GC) position and instructs the aircraft to switch to the GC radio frequency. The ground controller issues taxi clearance using visual observations or procedural separation and (at some airports) using the ASDE-2 surveillance information if his vision were obstructed. In issuing the taxi clearance, he also uses information on the aircraft's position in the sequence of departing and arriving aircraft. The aircraft follows the instructions of the ground controller and heads for the runway. As it approaches the runway and as it joins the departure queue, the pilot is advised to switch to the local controller radio frequency for further instructions. The local controller clears the aircraft onto the active departure runway and clears it for takeoff when an appropriate departure slot is available.

Departure Activities

As the aircraft gains in altitude, it is picked up by the ATCRBS/search surveillance sensors, and automatic tracking begins. The aircraft data block is displayed on the controller's ARTS III Plan View Display (PVD) adjacent to the aircraft position which is derived from the broadband surveillance data. Weather and aircraft target information are derived from a common search radar channel. The automatic track acquisition by ARTS causes a departure message to be sent automatically from the ARTS computer to the ARTCC computer. The departure controller in the TRACON monitors the progress of the aircraft as it traverses the airspace under his control, detecting and resolving conflicts as they arise. If the aircraft is in danger of violating

the minimum safe altitude, an automated warning is given to the controller by the terminal MSAW system. As the aircraft approaches the center boundary, the en route computer automatically initiates a track on the aircraft, based upon inputs from the en route ATCRBS sensors and based on correlating tracking information transferred automatically from the ARTS computer to the en route computer. Aircraft and weather surveillance information displayed in the en route system is all digital with broadband as backup.

The handoff initiation process is currently automatic and is conducted through an ARTS to en route computer communication. An indication of the process at hand is displayed to the TRACON controller on his PVD, and to the appropriate center controller on his PVD, in the form of a blinking display. Manual handoff acceptance is done by the en route controller through keyboard action. The TRACON controller then advises the aircraft to contact the en route center on the appropriate radio frequency. A display of the completion of the handoff process is provided to appropriate controllers.

En Route Activities

As the aircraft is about to enter the departure sector of the en route airspace, the planning controller (the D-man who assists the radar controller) examines other flights and flight data for conflicts with this particular flight. He does this by examining routes, altitudes, and times of arrival at certain fixes. He does this continuously to assure that all separation criteria are expected to be met. In the case of a potential conflict, he contacts the controllers of other sectors and requests a change of altitude, route or speed. Tracks and flight data are automatically transferred from a sector to an adjacent sector as the

aircraft flies through the en route system. Handoff between sectors is automatically initiated, and an indication of the beginning of the handoff process is displayed to the appropriate controllers on their PVDs.

Manual handoff acceptance through keyboard action is done by the "receiving" controller. After the handoff is completed, the aircraft is advised by the controller to change the radio frequency to that of the adjacent sector which is to be entered soon after the handoff. The planning controller of the "receiving" sector examines other flights and flight data for possible conflicts with this particular flight. Flight plan amendments are initiated based on a potential conflict or due to pilot requests. All of the above activities will be basically the same regardless of whether the aircraft is flying from sector to adjacent sector within the same center or whether those sectors happen to be in two different centers. Whenever the en route computer detects the presence of a potential conflict, a conflict alert is displayed on the PVDs of the sector or sectors involved (within the same center). The controller resolves the conflict by issuing appropriate commands to the aircraft. If another sector is involved he coordinates action with the radar controller of that sector. Violation of safe altitudes are detected by the controller by manually comparing aircraft altitudes and altitude changes with established minimum safe altitude. The controller advises the aircraft accordingly.

The aircraft finally enters the arrival sector of the ARTCC which serves the destination ARTS III facility. The controller of that en route sector gives the aircraft en route metering instructions, i.e., the time of arrival at the outer/coordination

fix. The en route controller's actions are based on his knowledge of the TRACON acceptance rate, desired spacing or desired arrival times communicated to him by the approach controller at the destination ARTS III facility.

Descent and Approach Activities

At a time parameter prior to the arrival of the flight into the TRACON airspace, the flight data on the arriving aircraft are transmitted from the En Route system to the TRACON controller through ARTS and FDEP. As the aircraft approaches the TRACON boundary, tracking is automatically accomplished by the ARTS computer and tracks are displayed to the controller on his TRACON display. These tracks are based both on ATCRBS terminal surveillance data and on correlating tracking information transferred from the en route computer to the ARTS computer. If a conflict suddenly developed, the en route controller is notified through the PVD by the flashing en route Conflict Alert. If necessary and appropriate, the controller communicates the conflict alert situation to the TRACON. As the aircraft descends towards the TRACON airspace, initiation of handoff is automatically done, and the controllers are alerted to that by means of a flashing display on both the TRACON PVD and the center PVD. The approach controller accepts the handoff by keyboard action. The en route controller advises the aircraft of contacting the approach control facility on the appropriate radio frequency. An indication of the handoff acceptance is displayed to all appropriate controllers. The approach controller then sequences the aircraft by giving commands which will result in delivering the aircraft in the proper sequence to the runway and without any potential conflicts. If such a conflict should develop, the controller detects and resolves the conflict. The Instrument Landing System (ILS) is used by the pilot for straight-in approaches

during low visibility conditions. Curved approaches are sometimes used during VFR weather for noise avoidance.

Landing Activities

As the aircraft approaches a distance of about five miles from the runway, the approach controller advises the aircraft to contact the local controller on the appropriate radio frequency. He also verbally (by interphone) contacts the local controller to initiate the handoff process. The local controller provides ATC services to the aircraft in the airspace within five miles from the airport and until the aircraft lands. In guiding the aircraft the local controller uses ASR/ATCBI BRITE Surveillance information provided by the TRACON facility. If the landing is successful, the aircraft would stay in contact with the local controller until it turns off of the active runway, whereupon the local controller hands off the aircraft to the ground controller. The ground controller determines the best routing and timing of the aircraft to the assigned gate, using visual observations, procedural separation or ASDE-2 under low visibility conditions. The ground controller issues the taxi clearances to the aircraft and monitors it as it follows those instructions in its path to the gate. The flight plan and associated data are removed from the active file a time parameter after landing.

4.2 Near Term ATC System

Preflight Activities

An expected change in the near term is the increased use of the Fuel Advisory Procedures (FAD), due to the availability of better delay forecasting at Central Flow Control. FAD procedures would allow controllers to give the aircraft delay credit for taking a portion of the aircraft expected delay on the ground instead of in air.

Departure Activities

A significant change to the current system that is expected to occur in the Near Term is in the area of the separation assurance functions where the controller would be alerted to the occurrence of a possible conflict by the automated Terminal Conflict Alert system.

En Route Activities

Several major changes are expected in the near term for the en route centers. First the planning controller (D-man) would no longer have to perform the conflict prediction associated with the planning activities manually, but would be provided with an automated Flight Plan Conflict Probe (FPCP) which would be triggered automatically based on handoff acceptance, and flight plan amendments. Additionally, the controller himself could manually initiate the conflict probe. The FPCP would not provide the controller with suggested resolutions for detected conflicts. It only predicts conflicts between a flight entering the sector airspace and other flights either already in the sector or that are programmed to be in the sector in a time frame such that flights being compared occupy common elements of the airspace (routes, fixes, etc.).

In the event that the aircraft were to descend below predefined minimum en route altitudes, an automatic alert would in the Near Term be given to the controller via the En Route Minimum Safe Altitude Warning (MSAW) system.

Another change is an enhancement to the metering function provided by the en route controller. Automated En Route Metering would be implemented which would aid the controller in providing aircraft with appropriate instructions on the time of arrival to an outer/coordination fix.

Better weather information would be available to the controller due to the establishment of the Center Weather Service Unit (CWSU). The CWSU meteorologist would be provided with an operating position for the collection, coordination, and dissemination of center weather information. The CWSU would be provided with three-dimensional weather data from the NWS radars.

Descent and Approach Activities

The Vortex Avoidance System (VAS) would provide indications to the controller of when reduced longitudinal separation between arrivals on final approach could be used, depending on the current wind conditions. Another major automation aid expected to be available for the TRACON radar controller in the Near Term is the Conflict Alert whereby the controller is provided with an alert on his PVD whenever a conflict situation arises.

Landing Activities

In the Near Term, the local controller may use data from the Low Level Wind Shear Alert System (LLWSAS) to advise aircraft how to avoid encounter with dangerous wind shear conditions. Depending on whether the VAS display indicates a green or a red signal, the local controller would use reduced separations or would revert back to increased longitudinal separations.

4.3 Far Term ATC System

Preflight Activities

A major change affecting preflight activities in the Far Term is expected to be brought about by the introduction of the Terminal Information Processing System (TIPS). Flight plan data would no longer be transmitted from the en route computer to ARTS III facilities via FDEP and the ARTS III system, but would

be transmitted from the en route computer to TIPS and stored there for later use by either ARTS III or the TIPS displays. Instead of printing the departure strips (as is currently done) to indicate en route clearance, departure information would be displayed by ETABS at the ARTCC departure sector, and would also be displayed by TIPS on a tabular display at the clearance delivery position in the tower cab. The clearance delivery position would continue (as in today's system) to deliver the clearance to the aircraft and to instruct the aircraft to contact the ground controller on the appropriate radio frequency. But when the aircraft is handed off to the ground controller, the TIPS keyboard would be used to cause the flight data to be displayed on the ground controller's display instead of the current passing of flight strips. The ground controller may issue taxi clearances based on procedural separation or using improved ASDE (ASDE-3) surveillance information if ground visibility was obscured. ASDE-3 is not only expected to replace ASDE-2, but it is also expected to have wider deployment than the current ASDE-2. The ground controller may also use the TAGS surveillance information which is expected to be introduced in tower cabs of a few ARTS III facilities in the Far Term to provide alphanumeric aircraft identification to be associated with displayed airport traffic. In issuing clearances, the ground controller would use the sequence established by the M&S system at the TRACON facility.

Departure Activity

In the surveillance area, the major change expected in this phase of the flight in the Far Term is that the DABS surveillance information would be available to the controller. The ground surveillance sites would have the capability of interrogating

both DABS and ATCRBS equipped aircraft. The use of DABS discrete addressing would enhance the quality of information available to the controller since there is no possibility of garbling associated with the DABS interrogations and replies. Furthermore, en route tracking would be based on the en route DABS/ATCRBS sensor information, but targets at facility boundary would be correlated with the terminal DABS/ATCRBS surveillance data.

Another significant change in the surveillance data display at the TRACON facility is that the display would be based on digitized search and beacon radar and ARTS would no longer use broadband surveillance data, except for back-up.

Another change impacting the flight data available to the TRACON controller, is the availability of the TIPS computers. Timely and "current" flight plan and weather data would be provided to the controller through TIPS. The controller would no longer use flight progress strips, but would use TIPS units for the entry as well as the retrieval of flight and weather information.

Conflict Alert would be complemented by the Conflict Resolution Advisory improvement which would automatically provide the controller with a recommended solution to the conflict. However, should the conflict continue to exist after the issuance of a conflict alert, collision avoidance messages would be issued to the pilot by the Automated Traffic Advisory and Resolution Service (ATARS). These messages would be conveyed to the pilot via the DABS Data Link and the controller would be advised of them. If, however, the aircraft is faced with a conflict outside surveillance coverage, the BCAS system would provide collision

avoidance advisories in the case of a conflict with aircraft equipped with either a DABS or ATCRBS transponder with altitude reporting capability.

Air Traffic Controllers at some of the ARTS III terminal facilities would be provided with three dimensional weather turbulence information from the Joint Use Weather Radar. At other facilities, controllers would be provided with weather turbulence information from the ASR radar which would be modified to incorporate pulse doppler techniques. The controllers in the major terminal areas would therefore be equipped with better information to deal with thunderstorms and turbulent weather.

En Route Activities

A major change in this phase of the flight is the availability to the controller of the DABS surveillance information which would be displayed if the aircraft is equipped with a DABS transponder. The DABS Data Link would also be made available for the possible transmission of ATC and other advisory messages. Another change expected in this phase of the flight in the Far Term is due to the implementation of ETABS. Whenever the Flight Plan Conflict Probe is exercised (due to a handoff or a flight plan amendment), the planning controller would be advised of a conflict, if any, by means of the ETABS display. Further, the automated handoff initiation process would be communicated to the controllers via the ETABS as well as the PVD displays. When a conflict alert is issued, the controllers would be alerted by both the PVD and ETABS and a recommended solution would be displayed to the controller. This solution would be automatically generated by the Conflict Resolution Advisory which would be implemented in the en route centers in Far Term. If the conflict

persists, the ATARS issues advisories to the pilot via the data link and the controller is informed of them.

Another change in the far term involves an automated interface between En Route Metering and the terminal Metering and Spacing (M&S) systems. It is expected that either the desired spacing, a desired time of arrival at a fix, or the acceptance rate would be conveyed digitally to the en route system. En route metering information would also be relayed by the automated interface to the terminal Metering and Spacing system. Furthermore, tied into the interface between M&S and En Route metering is the use of optimum descent profiles with the objective of minimizing the aircraft operating costs and minimizing the expenditure of fuel. Different airlines may have different descent profiles that they prefer to use. These profiles could also vary for any one airline depending on environmental conditions. The En Route Metering advisories delivered to the controller are expected to be conflict free because of the anticipated integration of the Flight Plan Conflict Probe and the En Route Metering functions.

Turbulent weather information would be made available to the controller from the Joint Use Weather Radars. Additionally, the weather detection in general would be optimized at the ARSRs by the use of a separate ARSR weather channel.

Descent and Approach Activities

As the aircraft approaches the TRACON/center boundary, the flight plan data would be communicated from the ARTCC to the ARTS III facility through TIPS. Thus, the controllers in the ARTS III facilities would no longer use flight strips. As in other time

frames, surveillance and tracking information would be communicated for correlation from the en route computers to the ARTS computers with differences being that the transmitted information would be based on DABS surveillance instead of ATCRBS for those aircraft that are appropriately equipped, and that this information would go through TIPS. In the Far Term, it is expected that ARTS III would no longer use broadband surveillance data for the PVD displays, but would use digitized information. Automated handoff initiation to the TRACON would be displayed to the TRACON controller on his PVD.

A major change expected in this phase of the flight in the far term is the availability of automated aids for the Metering and Spacing (M&S) function to assist the approach controller in conducting his duties. The M&S algorithm would include multiple runways, arrivals, departures, tower en route and VFR aircraft. It is also expected that profile descents based on the controller's request would be considered by the M&S algorithm. Optimum profile descents for various aircraft and under various conditions would be provided by the aircraft operators.

The TRACON controller in charge of metering and spacing is expected to obtain information from a more sophisticated tower cab automation aid that would predict the wake vortices based on environmental conditions and aircraft characteristics. Currently, the Wake Vortex Avoidance System (WVAS) and the M&S system designs include limited provisions for an automated interface. A more extensive interface would permit M&S to automatically assist the controller with reorganizaing the arrival stream when suggested longitudinal separation standards are changed based on varying wake vortex conditions.

Another expected change is the detection of potential aircraft collisions. If the aircraft was faced with a conflict with another aircraft, a recommended solution is displayed to the controller. This solution would be generated automatically by the Terminal Conflict Resolution Advisory function. If the conflict alert persists, the ATARS system would provide messages to the pilot via the DABS Data Link, and the controller would be advised of these messages. If the aircraft in the terminal area is outside the ATARS service area, the airborne collision avoidance system, BCAS, provides appropriate commands to the pilot, provided the aircraft is BCAS equipped and the intruding aircraft has either a DABS or ATCRBS transponder with altitude reporting capability.

Another expected change associated with descent is due to the introduction of the Microwave Landing System (MLS). As the aircraft enters the approach airspace, it could use MLS for precision guided curved approaches. At some locations, these approaches could make more flexible use of existing airspace than the straight-in ILS type of approaches.

Landing Activities

As the aircraft approaches the tower, the approach controller would hand-off the aircraft to the local controller. Flight data would appear on the local controller's TIPS display, and on his situation display. During landing, the local controller would advise the aircraft of the data on environmental conditions. This data is made available to him through the Wake Vortex Avoidance System (WVAS) and the Advanced Wind Shear Detection System (AWSDS). WVAS and AWSDS information would be displayed via the ATC Tower Consolidated Display (ACD). Furthermore, digital surveillance

data is made available to the local controller through the Tower Cab Digital Display (TCDD). TCDD improves the display presentation. When the aircraft lands and upon turning off the active runway, the local controller would handoff the aircraft to the ground controller by TIPS keyboard action. The ground controller would issue taxi instructions using visual observation, procedural separation or ASDE-3/TAGS ground surveillance information if the airport is so equipped and if the controller's vision is obstructed. The flight plan would be taken off active file from both en route and TIPS computers according to certain pre-defined time parameters after landing.

4.4 Single Thread Summary

Tables 4-1 through 4-5 present a summary of the operational activities associated with the single thread of an IFR air carrier flight through high density airspace. The tables illustrate how the events associated with the single thread change in time depending on the system configuration. Table 4-1 discusses preflight activities; departure activities are summarized in Table 4-2; Table 4-3 addresses en route activities; Table 4-4 illustrates descent and approach; and finally, Table 4-5 illustrates landing activities.

	CURRENT SYSTEM	NEAR TERM SYSTEM	FAR TERM SYSTEM
1	• FLIGHT PLANS (FP) BULK STORED ON MAGNETIC TAPES IN DEPARTURE ARTCC	NC	NC
2	• FP CHANGES/CANCELLATIONS ENTERED FROM AIRLINE DISPATCH OFFICE INTO 9020	NC	NC
3	• FP DATA TRANSMITTED TO DEPARTURE ARTS III FACILITY THROUGH ARTS AND FDEP	NC	* • FP DATA TRANSMITTED TO ARTS III FACILITY THROUGH A NAS-TIPS LINK.
4	• FP DATA TRANSMITTED TO ADJACENT CENTER THROUGH NAS COMPUTER LINK	NC	NC
5	• FP DATA TRANSMITTED FROM ARTCC TO DEPARTURE TOWER CAB THROUGH FDEP	NC	* • FP DATA TRANSMITTED FROM TIPS TO TOWER CAB DISPLAYS AS NEEDED.
6	• AIRCRAFT RECEIVES ATIS INFO (I.E., RUNWAYS IN USE, DEPARTURE ROUTES IN USE, NOISE ABATEMENT PROCEDURES, TERMINAL AREA WEATHER, PREDICTED DEPARTURE DELAYS, NOTAMS, ETC.)	NC	NC
7	• A DEPARTURE STRIP IS PRINTED AT ARTCC DEPARTURE SECTOR AND AT TOWER CAB.	NC	* • DEPARTURE INFORMATION IS DISPLAYED BY ETABS AT ARTCC DEPARTURE SECTOR. TIPS DISPLAYS DEPARTURE INFORMATION AT CLEARANCE DELIVERY POSITION.
8	• EN ROUTE CLEARANCE DELIVERED TO AIRCRAFT BY CLEARANCE DELIVERY POSITION IN TOWER CAB	NC	NC
9	• FLIGHT DATA (STRIP) TRANSFERRED TO GROUND CONTROL (GC) POSITION WHO ASSUMES CONTROL. AIRCRAFT INSTRUCTED TO SWITCH TO GC FREQUENCY	NC	* • CLEARANCE DELIVERY CAUSES FLIGHT DATA TO BE TRANSFERRED TO THE GROUND CONTROLLER'S TIPS DISPLAY. AIRCRAFT INSTRUCTED TO SWITCH TO G.C. FREQUENCY.
10	• GROUND CONTROLLER ISSUES TAXI CLEARANCE USING SEQUENCING INFORMATION, AND AT SOME AIRPORTS USES ASDE-2 FOR GROUND SURVEILLANCE IF VISION IS OBSTRUCTED.	NC	* • GROUND CONTROLLER ISSUES TAXI CLEARANCE USING TAGS ALPHA-NUMERIC SURVEILLANCE/DISPLAY (WHERE AVAILABLE) AND USING ASDE-3
11	• AS IT APPROACHES RUNWAY, A/C DIRECTED TO SWITCH TO THE LOCAL CONTROLLER FREQUENCY.	NC	NC
12	• LOCAL CONTROLLER (LC) CONFIRMS OR CHANGES DEPARTURE SLOT USING RUNWAY AVAILABILITY, AND WITHOUT THE BENEFIT OF AUTOMATED M&S.	NC	* • LOCAL CONTROLLER CONFIRMS OR CHANGES DEPARTURE TIME SLOT DEPENDING ON AUTOMATED M&S INFORMATION, AND RUNWAY AVAILABILITY.
13	• LC ISSUES TAKEOFF CLEARANCE. A/C DIRECTED TO SWITCH TO DEPARTURE CONTROLLER FREQUENCY.	NC	NC

NC = NO CHANGE INCLUDED IN CURRENT E&D PLANS.

	REMARKS
	PREFLIGHT PILOT BRIEFINGS ON WEATHER & AERONAUTICAL DATA PRECEDE FP FILING. AUTOMATED AIDS WILL BE PROVIDED TO THE FSS SPECIALISTS, IN BOTH NEAR AND FAR TERMS. IN THE LATTER ERA, PILOTS WOULD BE PROVIDED WITH A SELF BRIEFING CAPABILITY.
S III S LINK.	A TIME PARAMETER PRIOR TO DEPARTURE.
	A TIME PARAMETER PRIOR TO DEPARTURE.
IPS TO ED.	TIPS SERVICES BOTH TRACON AND TOWER CAB.
	ATIS COULD BE POTENTIALLY DELIVERED TO THE AIRCRAFT VIA THE DATA LINK.
IS- EPARTURE ARTURE ELIVERY	A TIME PARAMETER PRIOR TO DEPARTURE.
FLIGHT THE IS- TO	
AXI - AY C	
	A CANDIDATE FOR DELIVERY VIA DATA LINK.
OR T	

TABLE 4-1
SINGLE THREAD FOR AN AIR CARRIER FLIGHT – PREFLIGHT ACTIVITIES

	CURRENT SYSTEM	NEAR TERM SYSTEM	FAR TERM SYST
14	• AS A/C DEPARTS, AUTOMATIC TRACKING IS ACCOMPLISHED BY ARTS BASED UPON ATCRBS/ SEARCH RADAR SURVEILLANCE. BROADBAND SURVEILLANCE DATA DISPLAYED ON ARTS PVD.	NC	* • AS A/C DEPARTS, AUTOMATI IS ACCOMPLISHED BY ARTS DABS/ATCRBS/SEARCH RADAR DIGITIZED SURVEILLANCE D ON ARTS PVD.
15	• AUTOMATIC TRACK ACQUISITION CAUSES A DEPARTURE MESSAGE TO BE SENT AUTOMATICALLY FROM ARTS TO NAS.	NC	NC
16	• IF CONFLICT OCCURS, CONTROLLER HAS TO DETECT AND RESOLVE.	* • IF CONFLICT OCCURS, CONTROLLER IS ALERTED BY TERMINAL CONFLICT ALERT CONTROLLER RESOLVES CONFLICT MANUALLY. CA MAY BE COMMUNICATED TO ARTCC.	* • CONTROLLER IS AUTOMATIC WITH A CONFLICT RESOLUT IF CONFLICT PERSISTS, A ADVISORIES TO PILOT VIA AND CONTROLLER IS INFOR
17	• IF A/C IS DANGEROUSLY CLOSE TO VIOLATING MINIMUM SAFE ALTITUDES, TERMINAL MSAW WARNS CONTROLLER.	NC	NC
18	• SEARCH RADAR RETURNS ARE USED FOR WEATHER INFORMATION; WEATHER AND BEACON REPORTS ARE SENT OVER SAME CHANNEL.	NC	* • 3D WEATHER TURBULENCF I OBTAINED THROUGH JOINT RADAR. SEPARATE ASR CH USED TO OPTIMIZE WEATHE
19	• IF A/C IS OUTSIDE SURVEILLANCE COVERAGE AND IT GETS INTO A CON- FLICT SITUATION, PILOT DETECTS VISUALLY AND TAKES CORRECTIVE ACTION. CONTROLLER COULD ASSIST.	NC	* • IF A/C IS OUTSIDE SURVE COVERAGE AND GETS INTO FLICT SITUATION, BCAS W PILOT AND GIVES CORRECT COMMANDS.
20	• AS A/C APPROACHES CENTER/TRACON BOUNDARY, NAS TRACKS A/C BASED ON ATCRBS/SEARCH RADAR SENSORS AND CORRELATES WITH TRACKING INFOR- MATION TRANSFERRED AUTOMATI- CALLY FROM ARTS TO NAS.	NC	* • AS A/C APPROACHES CENTE BOUNDARY, NAS TRACKS A/ DABS/ATCRBS/SEARCH RADA AND CORRELATES WITH TRA FORMATION TRANSFERRED A FROM ARTS TO NAS THROUG
21	• AUTOMATIC HANDOFF INITIATION AND DISPLAY OF HANDOFF ON TRACON AND CENTER PVD.	NC	* • AUTOMATIC HANDOFF INITI DISPLAY OF HANDOFF ON T CENTER PVD AND ON CENT
22	• MANUAL HANDOFF ACCEPTANCE BY EN ROUTE CONTROLLER (THROUGH KEY- BOARD ACTION).	NC	NC
23	• AIRCRAFT ADVISED TO CHANGE RADIO FREQUENCY TO THAT OF ARTCC DEPARTURE SECTOR.	NC	NC

NC = NO CHANGE INCLUDED IN CURRENT E&D PLANS.

TERM SYSTEM	REMARKS
S, AUTOMATIC TRACKING ED BY ARTS BASED UPON EARCH RADAR SURVEILLANCE. VEILLANCE DATA DISPLAYED	
NC	• NAS -- ARTS COMMUNICATIONS ACCOMPLISHED THROUGH TIPS IN FAR TERM.
AUTOMATICALLY PROVIDED CT RESOLUTION ADVISORY. ERSISTS, ATARS ISSUES PILOT VIA DATA LINK R IS INFORMED OF THEM.	
NC	• A POTENTIAL IMPROVEMENT IS WARNING THE PILOT VIA DATA LINK.
RBULENCE INFORMATION UGH JOINT USE WEATHER ATE ASR CHANNELS ARE IZE WEATHER DETECTION.	• HAZARDOUS WEATHER INFORMATION COULD POTENTIALLY BE SENT TO PILOT VIA DATA LINK.
SIDE SURVEILLANCE GETS INTO A CON- ON, BCAS WARNS ES CORRECTIVE	
CHES CENTER/TRACON TRACKS A/C BASED ON EARCH RADAR SENSORS S WITH TRACKING IN- NSFERRED AUTOMATICALLY NAS THROUGH TIPS.	
DOFF INITIATION AND NDOFF ON TRACON AND D ON CENTER ETABS.	
NC	
NC	• THIS FUNCTION IS A CANDIDATE FOR DATA LINK.

TABLE 4-2
SINGLE THREAD FOR AN AIR CARRIER FLIGHT—DEPARTURE ACTIVITIES

PLANS.

2

	CURRENT SYSTEM	NEAR TERM SYSTEM	FAR TERM SYSTEM	
24	• PLANNING CONTROLLER OF DEPARTURE SECTOR EXAMINES FLIGHTS FOR CONFLICTS WITH NEW COMER.	* • FLIGHT PLAN CONFLICT PROBE (FPCP) AUTOMATICALLY INITIATED UPON HANDOFF. PLANNING CONTROLLER IS ADVISED (THRU CRD) OF POSSIBLE CONFLICTS. FP MAY BE AMENDED, NEW FPCP INITIATED.	* • FPCP IS AUTOMATICALLY INITIATED UPON HANDOFF. PLANNING CONTROLLER IS ADVISED THRU ETABS OF POSSIBLE CONFLICT. FP MAY BE AMENDED, NEW FPCP INITIATED.	
25	• AS A/C APPROACHES BOUNDARY OF DEPARTURE SECTOR, TRACKS & FLIGHT DATA ARE TRANSFERRED TO ADJACENT SECTOR.	NC	NC	BAS
26	• AUTOMATIC HANDOFF INITIATION & DISPLAY OF HANDOFF ON PVDs OF INVOLVED SECTORS.	NC	* • AUTOMATIC HANDOFF INITIATION & DISPLAY OF HANDOFF ON PVDs & ETABS OF INVOLVED SECTORS.	
27	• MANUAL HANDOFF ACCEPTANCE BY ADJACENT SECTOR (THRU KEYBOARD ACTION).	NC	NC	
28	• A/C ADVISED TO CHANGE RADIO FREQUENCY TO THAT OF ADJACENT SECTOR (IN SAME CENTER OR IN ADJACENT CENTERS).	NC	NC	• THIS
29	• PLANNING CONTROLLER OF "ACCEPTING" SECTOR EXAMINES FLIGHTS FOR CONFLICTS WITH NEW COMER.	* • FPCP TRIGGERED BY HANDOFF PROCESS.	NC	
30	• SEARCH RADAR RETURNS ARE USED FOR WEATHER INFORMATION. WEATHER AND BEACON REPORTS SENT OVER SAME CHANNEL.	* • CENTER WEATHER SERVICE UNIT (CWSU) ESTABLISHED FOR WEATHER INFORMATION COORDINATION. CWSU IS PROVIDED 3D WEATHER DATA FROM THE NWS RADAR.	* • 3D WEATHER TURBULENCE INFORMATION OBTAINED THRU JOINT USE (FAA/NWS/AWS) WEATHER RADAR. SEPARATE ARSR WEATHER CHANNEL WOULD BE USED TO OPTIMIZE WEATHER DETECTION.	• HAZA COUL PILO
31	• IF 9020 CENTRAL COMPUTER COMPLEX (CCC) FAILS, SEARCH RADAR BROADBAND INFORMATION IS USED. CONTROLLERS USE HORIZONTAL DISPLAYS WITH SHRIMP BOATS.	* • IF CCC FAILS, DARC PROVIDES BACKUP DISPLAY INFORMATION ON TO THE PVD.	NC	
32	• AS FLIGHT PROGRESSES THRU CENTER, FP AMENDMENTS MAY OCCUR & CONTROLLER RESOLVES CONFLICTS.	* • FP AMENDMENTS TRIGGER FPCP TO TEST FOR CONFLICTS. CRD AND KEYBOARD USED FOR MAN MACHINE COMMUNICATION.	* • FP AMENDMENTS TRIGGER FPCP TO TEST FOR CONFLICTS. ETABS IN ADDITION TO CRD AND KEYBOARD ARE USED FOR MAN MACHINE COMMUNICATION.	
33	• IF CONFLICT OCCURS, CONTROLLER IS ALERTED BY CA DISPLAY ON PVDs OF INVOLVED SECTORS IN SAME CENTER. CONTROLLER RESOLVES CONFLICT.	* • NC	* • IF CONFLICT OCCURS CONTROLLER IS ALERTED BY CA DISPLAY ON PVD & ETABS OF INVOLVED SECTORS IN THE SAME CENTERS. A RECOMMENDED SOLUTION IS DISPLAYED TO CONTROLLER. IF CONFLICT PERSISTS, ATARS ISSUES ADVISORIES TO PILOT VIA DATA LINK AND CONTROLLER IS INFORMED OF THEM.	
34	• IF A/C IS TOO CLOSE TO GROUND, CONTROLLER MONITORS AND ADVISES A/C.	* • EN ROUTE MSAW WILL PROVIDE CONTROLLERS WITH WARNING IF A/C IS TOO CLOSE TO GROUND.		PILO
35	• ARTS-III FACILITY ADVISES ARRIVAL SECTOR AT ARTCC OF TRACON TRAFFIC ACCEPTANCE RATE, DESIRED SPACING AND TIMING.	NC	* • METERING DATA WOULD BE INTERCHANGED BETWEEN ARTS III & EN ROUTE FACILITIES BY A DIGITAL LINK.	
36	• EN ROUTE CONTROLLER GIVES THE AIRCRAFT INITIAL METERING INSTRUCTIONS (TIME OF ARRIVAL AT OUTER/COORDINATION FIX) BASED ON TRACON ACCEPTANCE RATE.	* • EN ROUTE CONTROLLER GIVES THE AIRCRAFT INITIAL METERING INSTRUCTIONS (TIME OF ARRIVAL AT OUTER/COORDINATION FIX) USING EN ROUTE METERING AUTOMATION AIDS.	* • INTEGRATION OF EN ROUTE METERING AND FP CONFLICT PROBE ENHANCES CONFLICT FREE PLANNING.	• METI FOR

NC = NO CHANGE INCLUDED IN CURRENT E&D PLANS.

REMARKS
BASED ON A TIME PARAMETER.
• THIS FUNCTION IS CANDIDATE FOR DATA LINK.
• HAZARDOUS WEATHER INFORMATION COULD POTENTIALLY BE SENT TO PILOT VIA DATA LINK
PILOT COULD BE ALERTED VIA DATA LINK.
• METERING COMMANDS ARE CANDIDATE FOR DELIVERY BY DATA LINK.

TABLE 4-3
SINGLE THREAD FOR AN AIR CARRIER FLIGHT – EN ROUTE ACTIVITIES

2

	CURRENT SYSTEM	NEAR TERM SYSTEM	FAR TERM SYSTEM
37	• FP DATA ON ARRIVING AIRCRAFT TRANSMITTED FROM CENTER TO TRACON THRU ARTS & FDEP.	NC	* • FP DATA ON ARRIVING TRANSMITTED FROM CENTER TO TRACON THROUGH TIPS.
38	• AS A/C APPROACHES CENTER/TRACON BOUNDARY ARTS TRACKS A/C BASED ON ATCRBS/SEARCH RADAR SENSORS AND ON TRACKING INFORMATION TRANSFERRED AUTOMATICALLY FROM NAS TO ARTS. BROADBAND SURVEILLANCE DATA DISPLAYED ON ARTS PVD.	NC	* • AS A/C APPROACHES CENTER/TRACON BOUNDARY, ARTS TRACKS A/C BASED ON DABS/ATCRBS/SEARCH RADAR SENSORS AND ON CORRELATING TRACKING INFORMATION TRANSFERRED AUTOMATICALLY FROM NAS TO ARTS THROUGH TIPS. DIGITIZED SURVEILLANCE DATA DISPLAYED ON ARTS PVD.
39	• IF CONFLICT SUDDENLY DEVELOPS, EN ROUTE CA IS DISPLAYED ON CENTER CONTROLLER PVD. CONFLICT IS COMMUNICATED VERBALLY TO TRACON IF APPLICABLE.	NC	* • CA IS DISPLAYED ON ARTCC PVD. CONFLICT RESOLUTION ADVISORIES ARE AUTOMATICALLY PROVIDED. IF CONFLICT PERSISTS, ATARS ISSUES ADVISORIES TO PILOT VIA DATA LINK, AND CONTROLLER IS INFORMED OF THEM.
40	• AUTOMATIC HANDOFF INITIATION & DISPLAY OF HANDOFF ON TRACON AND CENTER PVD.	NC	* • AUTO HANDOFF INITIATION AND DISPLAY ON HANDOFF ON TRACON AND CENTER PVDs AND ON CENTER ETABS.
41	• MANUAL HANDOFF ACCEPTANCE BY TRACON CONTROLLER (THRU KEYBOARD ACTION).	NC	NC
42	• A/C ADVISED TO CHANGE RADIO FREQUENCY TO THAT OF TRACON APPROACH CONTROL.	NC	NC
43	• APPROACH CONTROLLER SEQUENCES THE A/C AND RESOLVES POTENTIAL CONFLICTS AS HE REFINES THE SEQUENCING OF THE A/C.	* • A CERTAIN LONGITUDINAL SEPARATION STANDARD RECOMMENDED BASED ON VAS.	* • AUTOMATED METERING & SPACING (M&S) AIDS THE APPROACH CONTROLLER IN GUIDING THE A/C IN HIS AIRSPACE. VAS/WVAS PROVIDES LONGITUDINAL SEPARATION STANDARDS. M&S INTERFACES WITH CONFLICT ALERT.
44	• IF CONFLICT SUDDENLY DEVELOPS, CONTROLLER HAS TO DETECT AND RESOLVE.	* • IF CONFLICT SUDDENLY DEVELOPS, CONTROLLER IS ALERTED BY TERMINAL CA.	* • IF CONFLICT DEVELOPS CONTROLLER IS ALERTED BY TERMINAL CA. CONFLICT REOSLUTION ADIVSORIES ARE AUTOMATICALLY PRESENTED TO CONTROLLER ON DISPLAY. IF CONFLICT PERSISTS, ATARS ISSUES ADVISORIES TO PILOT VIA DATA LINK AND CONTROLLER IS ADVISED OF THEM.
45	• CURVED APPROACHES DURING VFR WEATHER FOR NOISE AVOIDANCE. STRAIGHT IN APPROACH DURING LOW VISIBILITY USING ILS GUIDANCE.	NC	* • A/C COULD EXECUTE PRECISION GUIDED CURVED APPROACH USING MLS UNDER BOTH IFR AND VFR CONDITIONS.

NC = NO CHANGE INCLUDED IN CURRENT E&D PLANS.

	REMARKS
S.	• A TIME PARAMETER PRIOR TO BOUNDARY CROSSING.
S AND ON S TO VEIL-	
- ICT	
AY VDs	
	• CANDIDATE FOR DATA LINK.
D UIDING S PRO- DARDS. T.	• AUTOMATED INTERFACE BETWEEN WVAS AND M&S MAY BE USED. M&S COMMANDS COULD BE POTENTIALLY COMMUNICATED TO PILOT VIA DATA LINK.
S ICALLY T. S - D	

TABLE 4-4
SINGLE THREAD FOR AN AIR CARRIER FLIGHT - DESCENT AND APPROACH ACTIVITIES

	CURRENT SYSTEM	NEAR TERM SYSTEM	FAR TERM SYSTEM
46	• APPROACH CONTROLLER ADVISES A/C TO CONTACT LOCAL CONTROLLER (LC) AT THE LC RADIO FREQUENCY.	NC	NC
47	• APPROACH CONTROLLER CONTACTS LC BY INTERPHONE TO HANDOFF CONTROL OF A/C.	NC	* • BY KEYBOARD ACTION APPROAC TROLLER CAUSES FLIGHT DATA ON LC TIPS AND SITUATION DI THUS HANDING OFF A/C CONTR LOCAL CONTROLLER.
48	• LOCAL CONTROLLER PROVIDES ATC SERVICES TO A/C DURING LANDING. BRITE DATA IS AVAILABLE TO LC.	* • LC ADVISES A/C OF WIND SHEAR CONDITIONS USING LLWSAS DATA. LC ASCERTAINS THAT SEPARATION IS CONSISTENT WITH VAS ADVISORES.	* • LC ADVISES A/C OF ENVIRONM CONDITIONS USING WVAS AND A DIGITAL SURVEILLANCE DATA I AVAILABLE TO LC THROUGH TC
49	• UPON LANDING AND TURNING OFF THE ACTIVE RUNWAY LOCAL CONTROLLER HANDS OFF A/C TO GROUND CONTROLLER (GC). LC ADVISES A/C TO CONTACT GC ON GC RADIO FREQUENCY.	NC	* • UPON LANDING AND TURNING O ACTIVE RUNWAY, LC BY KEYBOA CAUSES FLIGHT DATA TO APPEA GROUND CONTROLLER TIPS DIS
50	• GC DETERMINES BEST ROUTE TO ASSIGNED GATE USING ASDE-2 GROUND SURVIELLANCE WHERE AVAILABLE AND IF VISION IS OBSTRUCTED.	NC	* • GC DETERMINES BEST ROUTE T GATE USING ASDE-3 OR TAGS AT SOME AIRPORTS.
51	• GC ISSUES TAXI INSTRUCTIONS.	NC	NC
52	• A TIME PARAMETER AFTER LANDING THE FLIGHT PLAN IS TAKEN OFF ACTIVE FILE IN THE NAS SYSTEM.	NC	* • A TIME PARAMETER AFTER LA FLIGHT PLAN IS TAKEN OFF A IN BOTH NAS AND TIPS

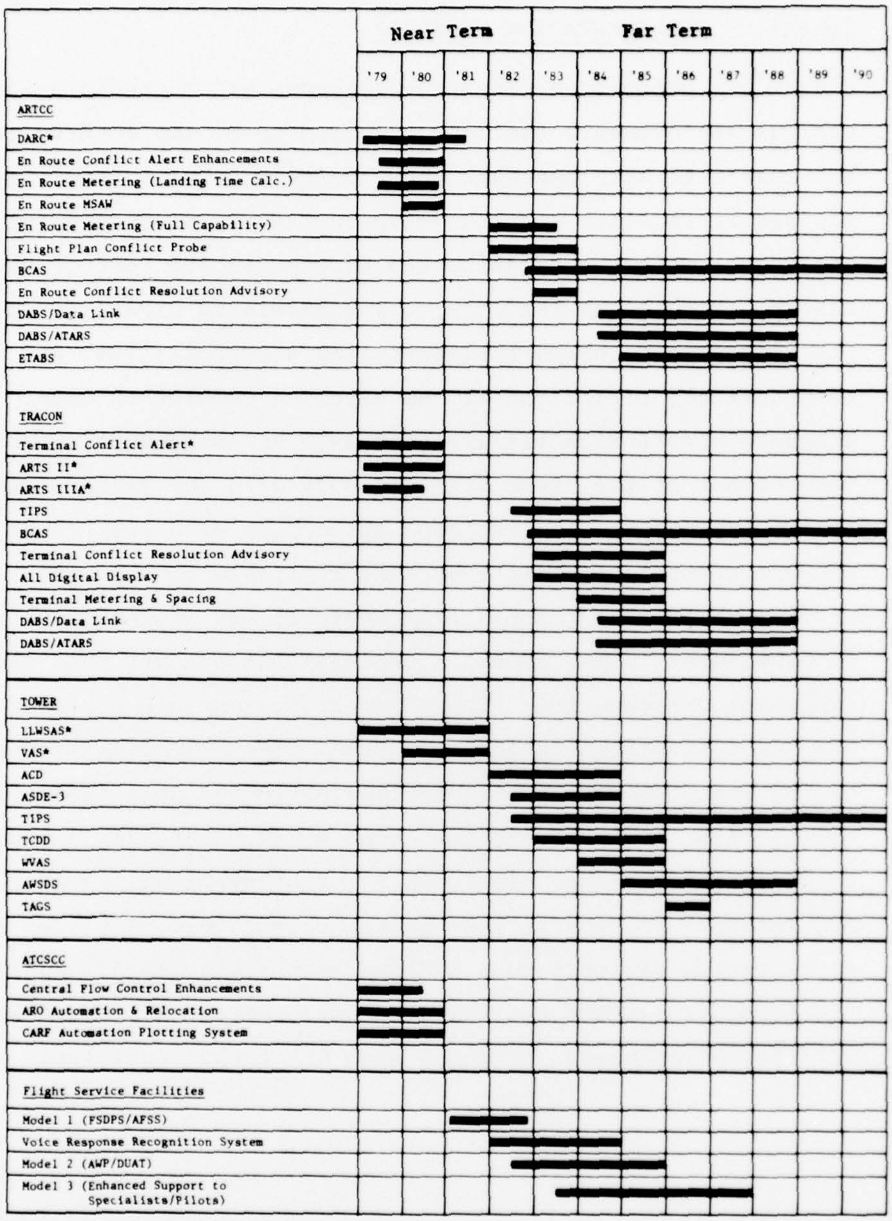
NC = NO CHANGE INCLUDED IN CURRENT E&D PLANS.

EM	REMARKS
	• A CANDIDATE FOR DATA LINK.
OACH CON- ATA TO APPEAR DISPLAYS. TROL TO	
ONMENTAL ND AWSDS. TA IS TCDD.	
G OFF THE YBOARD ACTION PPEAR ON DISPLAY.	• FREQUENCY CHANGE COMMAND IS CANDIDATE FOR DELIVERY VIA DATA LINK.
TE TO ASSIGNED AGS SURVEILLANCE	
	• A CANDIDATE FOR DATA LINK.
LANDING, THE FF ACTIVE FILE	

TABLE 4-5
SINGLE THREAD FOR AN AIR CARRIER FLIGHT - LANDING ACTIVITIES

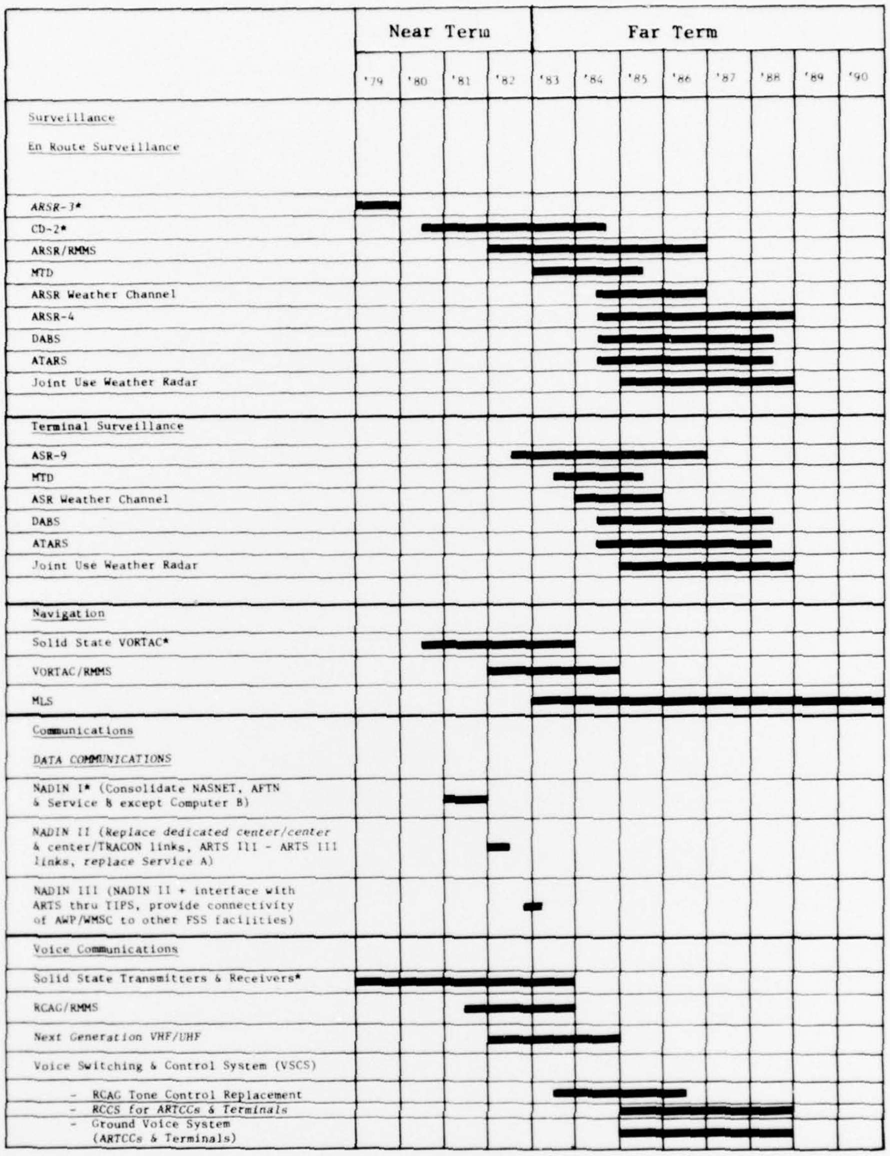
5. TENTATIVE IMPLEMENTATION SCHEDULE

Figure 5-1 presents a tentative implementation schedule for the various improvements that are expected to be implemented in the ATC system in both the Near and Far Terms. The schedule is organized by facility starting with the ARTCC and proceeding in accordance with the organization adopted in the rest of this report. Within any facility, the schedule is organized so that the improvements whose implementation starts earliest are mentioned first, regardless of the expected completion date. The schedule starts with the expected date of implementation of the improvement at the first site and ends with the implementation at the last site. The implementation date at a site means that the operational capability becomes available at that site. Some of the schedules reflect an FAA approval for implementation but in many cases (e.g., ETABS) a decision has not yet been made to implement the function. Those functions that are approved by the FAA for implementation are noted. The schedules are based on the best estimate available from personnel associated with the specific projects listed. Some of the schedules may prove to be optimistic when viewed in light of availability of funds and internal FAA priorities; hence, they should be viewed as representing earliest possible implementation dates. Additionally, the schedules assume that all the improvements discussed herein will be implemented. That may also be another optimistic view.



*Approved by the FAA for Implementation

FIGURE 5-1
SYSTEM IMPROVEMENTS TENTATIVE IMPLEMENTATION SCHEDULE



*Approved by the FAA for Implementation

FIGURE 5-1
SYSTEM IMPROVEMENTS TENTATIVE IMPLEMENTATION SCHEDULE (CONCLUDED)

APPENDIX A

ABBREVIATIONS AND ACRONYMS

ABDIS	Automated Service B Data Interchange System
ACD	Airport Traffic Control Tower Consolidated Display
ACD	Automatic Call Distribution
AERA	Automated En Route Air Traffic Control
AFCD	Airport Facilities Consolidated Display
AFOS	Automation of Field Operations and Services
AFS	Airway Facilities Service
AFSS	Automated Flight Service Station
AFTN	Aeronautical Fixed Telecommunications Network
A/G	Air/Ground
A/G/A	Air to Ground to Air
AGL	Above Ground Level
AIRS	Airport Information Retrieval System
ALWOS	Automated Low-Cost Weather Observation Systems
ARO	Airline Reservation Office
ARSR	Air Route Surveillance Radar
ARTCC	Air Route Traffic Control Center
ARTS	Automated Radar Terminal System
ASDE	Airport Surface Detection Equipment
ASR	Airport Surveillance Radar
ATARS	Automated Traffic Advisory and Resolution Service
ATCBI	Air Traffic Control Beacon Interrogator
ATCRBS	Air Traffic Control Radar Beacon System
ATCSCC	Air Traffic Control Systems Command Center
ATIS	Automated Terminal Information System
ATS	Automated Terminal Services
AUTOVON	Automatic Voice Network
AV-AWOS	Aviation Automated Weather Observation System
AWP	Aviation Weather Processor
AWS	Air Weather Service
AWSDS	Advanced Wind Shear Detection System
AWSS	Airborne Wind Shear System
BCAS	Beacon-Based Collision Avoidance System
BRITE	Bright Radar Indicator Tower Equipment
BUEC	Back-Up Emergency Communications
CAL	Commercial Airlines
CARF	Central Altitude Reservation Function
CCC	Central Computer Complex
CCP	Contingency Command Post
CCTV	Closed Circuit Television
CD	Common Digitizer

CDC	Computer Display Channel
CFC	Central Flow Control
CFJC	Central Flow Jacksonville Computer
CMA	Control Message Automation
CONUS	Conterminous United States
CRD	Computer Readout Device
CS/T	Combined Station/Tower
CTA	Calculated Time of Arrival
CWSU	Center Weather Service Unit
DABS	Discrete Address Beacon System
DARC	Direct Access Radar Channel
DCS	Data Communications Subsystem
DDD	Direct Distance Dialing
DEDS	Data Entry and Display Subsystem
DF	Direction Finder
DME	Distance Measuring Equipment
DR&A	Data Recording and Analysis
DTE	Data Terminal Equipment
DUAT	Direct User Access Terminal
EBCDIC	Extended Binary Coded Decimal Interchange Code
EFAS	En Route Flight Advisory Service
EMSAW	En Route Minimum Safe Altitude Warning System
ETABS	Electronic Tabular Display Subsystem
FAD	Fuel Advisory Departure
FAX	Facsimile
FDAD	Full Digital ARTS Display
FDEP	Flight Data Entry and Printout
F&E	Facilities and Equipment
FP	Flight Plan
FSAS	Flight Service Automation System
FSDPS	Flight Service Data Processing System
FSH	Flight Service Hub
FSS	Flight Service Station
FTS	Federal Telephone System
FWS	Flight Watch Specialist
FX	Foreign Exchange
GA	General Aviation
GPS	Global Positioning System
GOES	Geostationary Operational Environmental Satellite
HSP	High Speed Printer
HUD	Head Up Display

ICAO	International Civil Aviation Organization
IFR	Instrument Flight Rules
IFSS	International Flight Service Station
ILS	Instrument Landing System
IOCE	Input/Output Control Element
LASS	Line Automatic Sensing and Switching
LF	Low Frequency
LLWSAS	Low Level Wind Shear Alert System
LORAN	Long Range Navigation
LRCO	Limited Remote Communications Outlets
LSR	Limited Surveillance Radar
MIL	Military
MLF	Medium Low Frequency
MLS	Microwave Landing System
M&S	Metering and Spacing
MSAW	Minimum Safe Altitude Warning
MTBF	Mean Time Between Failure
MTBR	Mean Time Between Repair
MTD	Moving Target Detector
MTI	Moving Target Indicator
NADIN	National Airspace Data Interchange Network
NAFAX	National Facsimile Circuit
NAFEC	National Aviation Facilities Experimental Center
NAS	National Airspace System
NASCOM	National Aviation Systems Communications
NATCOM	National Communications
NAVAID	Navigational Aid
NDB	Nondirectional Beacon
NOAA	National Oceanic and Atmospheric Administration
NORAD	North American Air Defense Command
NOTAM	Notice to Airmen
NMC	National Meteorological Center
NWS	National Weather Service
OAG	Official Airline Guide
ORD	Operational Readiness Demonstration
OTC	Over the Counter
PATWAS	Pilot Automatic Telephone Weather Answering Service
PDME	Precision DME
PIREP	Pilot Weather Report
PVD	Plan View Display

RCAG	Remote Communications Air-Ground
RCO	Remote Communications Outlet
RCCS	Radio Communications and Control System
RCS	Radio Communications Subsystem
RDF	Radio Direction Finder
RML	Radar Microwave Link
RMMS	Remote Maintenance Monitor System
RNAV	Area Navigation
R/T	Receiver/Transmitter
RTR	Remote Transmitter/Receiver
RVR	Runway Visual Range
Rx	Receiver
SAC	Strategic Air Command
SAM	System Acquisition Management
SAMOS	Semi-Automated Meteorological Observation System
SCC	(ATC) System Command Center
SFO	Single Frequency Outlet
SFSS	Satellite Field Service Station
SMMC	System Maintenance Monitoring Console
SRAP	Sensor Receiver and Processor
SRG	Systems Requirements Group
STC	Sensitivity Time Control
SWL	Severe Weather Labs
SVSS	Small Voice Switching System
TAC	Tactical Air Command
TACAN	Tactical Air Navigation
TAGS	Tower Automated Ground Surveillance System
TCDD	Tower Cab Digital Display
TCS	Technical Control Subsystem
TDP	Technical Data Package
TIPS	Terminal Information Processing System
TSARC	Transportation Systems Acquisition Review Council
TRACAB	Terminal Radar Approach Control, Tower Cab
TRACON	Terminal Radar Approach Control, IFR Room
TRSB	Time Reference Scanning Beam
TTY	Teletypewriter
TWEB	Transcribed Weather Broadcast
Tx	Transmitter
VAS	Vortex Advisory System
VASI	Visual Approach Slope Indicator
VCS	Voice Communications Subsystem
VFR	Visual Flight Rules
VICON	Visual Confirmation of Voice Takeoff Clearance
VLF	Very Low Frequency

VMC	Visual Meteorological Conditions
VOR	Very High Frequency Omnirange Station
VORTAC	Colocated VOR and TACAN
VRS	Voice Response System
VSCS	Voice Switching Control System
V.T.	Vacuum Tube
WAVE	Wind and Altimeter Voice Equipment
WBRR	Weather Bureau Remote Radar Recorder
WECO	Western Electric Company
WFMU	Weather and Fixed Map Unit
WMSC	Weather Message Switching Center
WSFO	Weather Service Forecast Office
WSR	Weather Service Radar
WVAS	Wake Vortex Avoidance System
Wx	Weather

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